# A COMPARISON OF DEMOGRAPHIC VARIABLES AND POSTURE BETWEEN PATIENTS WITH CHRONIC CERVICAL PAIN AND HEALTHY VOLUNTEERS

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# ABSTRACT


Physiotherapists commonly assess head and shoulder posture and correct poor posture on the grounds that there is an association between the patients' cervical symptoms and their posture. The aims of this study were firstly to compare the sagittal head and shoulder posture and demographic variables of patients with chronic cervical pain to those of "healthy" volunteers. Secondly, to investigate the relationship between the frequency and severity of pain and the sagittal head and shoulder posture of patients with chronic cervical pain.

Lateral view photographs were taken of nineteen patients (experimental group) and eighteen "healthy" volunteers (control group) in a supported sitting position. The following five static postural positions were assessed: (1) neutral or natural head and shoulder posture (2) maximum head protraction (3) maximum head retraction (4) maximum shoulder protraction and (5) maximum shoulder retraction. The active range of anteroposterior glide (total excursion) of the participants' head and shoulders was also assessed. The participants completed a questionnaire that included their demographic variables, medical history and leisure time activities.

Differences in head and shoulder posture were observed between the two groups. Some of these differences supported postural relationships that have been described in the literature. The experimental group had a more forward head resting position than the control group. The range of motion (total excursion) of the head and shoulders of the experimental group was less than the control group. In contrast to clinical assumptions that have been described in the literature, a forward resting head posture was not related to a protracted shoulder position or to upper cervical spine extension when measured in the sagittal plane.

A relationship was observed between the frequency and severity of pain in certain body regions and selected postural measurements in the experimental group. It is suspected that most of the findings might be the result of poor cervical and scapular muscle control caused by chronic pain. This emphasises the need to assess the influence of tissue and joint extensibility and muscle control on head and shoulder posture.

Analysis of the questionnaires demonstrated that the experimental group's ability to carry out activities of daily living was significantly affected by pain (p=0,001). There was no significant difference in the number of hours worked per week between the experimental and control groups (p=1,000). There was a tendency (p=0,118) for the control group to devote a greater number of hours to "active" leisure time activities. The control group might have been less symptomatic as a result thereof. This highlights the necessity to further investigate the effect of exercise on postural correction and prevention of cervical symptoms.

# DECLARATION

I declare that this research report is my own, unaided work. It is being submitted for the degree of M.Sc Physiotherapy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

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# 1 INTRODUCTION

Physiotherapists frequently treat patients complaining of cervical pain. In my clinical experience I have observed that many of the patients presenting for treatment of cervical pain have a head forward posture, as described in the literature. Posture is considered by many clinicians to be an important factor in dysfunction and pain. As a part of physiotherapy intervention, patients are often advised about their habitual postures in relation to musculoskeletal pain, although the basis for this advice is mostly anecdotal and not based on quantitative studies.

There are many references in the literature that support the relationship between posture and cervical pain (Braun 1991, Darling 1984, Griegel-Morris et al 1992, Janda 1988, Kendall et al 1970, Lezberg 1966, Mottram 1997). However there are limited studies that further explore the relationship between postural abnormalities and the frequency and severity of pain. A clearer, quantified understanding of the relationships between physical characteristics will enhance the effectiveness of both therapeutic and educative intervention.

This motivated me to firstly compare the sagittal head and shoulder posture and demographic variables of patients with chronic cervical pain to those of “healthy” volunteers. Secondly, to investigate the relationship between the frequency and severity of pain and sagittal head and shoulder posture of patients with chronic cervical pain.

## 1.1 Aims of the study

The aims of the study were to:

1.1.1 compare the sagittal head and shoulder posture and demographic variables of patients with chronic cervical pain to those of “healthy” volunteers;

1.1.2 investigate the relationship between the frequency and severity of pain and the sagittal head and shoulder posture of patients with chronic cervical pain.

## 1.2 Objectives of the study

The objectives of the study were to:

1.2.1 compare the demographic variables, medical history and leisure time activities of patients with chronic cervical pain to those of “healthy” volunteers;

1.2.2 compare the sagittal head and shoulder posture of patients with chronic cervical pain to that “healthy” volunteers; and

1.2.3 describe the relationship between the frequency and severity of pain and the sagittal head and shoulder posture of patients with chronic cervical pain.

# 2 LITERATURE REVIEW

## 2.1 Posture and pain

Physiotherapists commonly assess posture and correct poor posture on the grounds that it is associated with pain. In the literature, pain is frequently associated with poor posture (Braun 1991, Griegel-Morris et al 1992, Kendall et al 1970, Lezberg 1966). There is no evidence yet to suggest that one cervical resting posture is more closely associated with pain than any other (Griegel-Morris et al 1992, Grimmer 1997).

Ideal posture is believed to be a state of musculoskeletal balance that involves a minimum amount of stress or strain to the body (Kendall et al 1993). Erect human posture is often assessed in the sagittal plane using a vertical reference, as in this view the body's response to gravitational forces can be observed (Dalton and Coutts 1995, Grimmer 1997). Kendall described a theoretical plumb line that divides the body into an anterior and posterior section of approximately equal weight. In the sagittal plane, the position of the head is adequate if this theoretical plumb line intersects the most posterior point of the tragus of the ear. The plumb line bisects the shoulder joint (Kendall et al 1970, Kendall et al 1993).

A number of authors have questioned the correction of all perceived poor posture to approximate the gravitational plumb line (Dalton and Coutts 1995, Griegel-Morris et al 1992, Grimmer 1997, Harrison et al 1996). Kendall et al (1970) claimed never to have examined an individual with posture perfectly aligned with the plumb line. Penning (1978) observed a wide variation of cervical spine posture in the sagittal plane in subjects who had never sustained an injury to the cervical spine. Grimmer (1997) measured the cervical excursions of four hundred and twenty seven healthy subjects. She also found that not one of the subjects had a cervical posture that aligned perfectly with the plumb line. The subjects demonstrated a considerable variability in the excursion angles of the upper and lower cervical spine.

The postural characteristics cited in the literature, as being particularly relevant to pain located in the craniofacial, cervical, interscapular, shoulder and pectoral regions, and down the upper limb, is the forward head posture and "rounded" or protracted shoulders (Ayub et al 1984, Braun 1991, Braun and Amundson 1989, Darling 1984, Mannheimer and Rosenthal 1991). When viewing a subject in the sagittal plane, a forward head position is defined as an excessively anterior position of the head in relation to the theoretical plumb line (Braun and

Amundson 1989). The head forward posture is considered to co-exist with hyperextension of the upper cervical region, a decrease of the mid and lower cervical lordosis, an alteration of the upper thoracic kyphosis, protraction and elevation with downward rotation of the scapulae, internal rotation of the humeri and elevation of the first and second ribs (Ayub et al 1984, Braun and Amundson 1989, Darnell 1983, Kendall et al 1993). The position of the shoulder is determined by the position of the scapula, clavicle and humerus. As the scapula moves in an anterolateral direction in relation to the thorax the shoulder becomes more protracted. The three dimensional movement of the scapula, therefore changes the position of the anatomical landmarks of the shoulder. A protracted shoulder posture is traditionally detected by the anteromedial position of the bicipital tendon groove relative to the theoretical plumb line (Braun and Amundson 1989).

In a forward head posture the cranium is posteriorly rotated in relation to the hyperextension of the upper cervical spine. In this position, the angle between the sternocleidomastoid and clavicle approaches 60 degrees as opposed to the more ideal 45-degree angle. As the head is brought into a position of axial extension or head retraction, the cervical lordosis flattens and the cranium is anteriorly rotated in relation to the cervical spine. In this position the angle between the sternocleidomastoid muscle and the clavicle is more acute. This excessively retracted position would place the tragus of the ear posterior to the plumb line. Between these two extremes lies the neutral or natural head position. In this position, the angle between a horizontal line transecting the spinous process of the seventh cervical vertebra and a line connecting the tragus of the ear with the spinous process of the seventh cervical vertebra is approximately 50-degrees. This angle is known as the craniovertebral angle. The neutral position provides balanced muscle force and structural alignment (Ayub et al 1984, Braun and Amundson 1989, Darling et al 1984).

It has been hypothesised that the habitual use of flexed postures of the head and neck throughout life could facilitate the progression of a forward head posture (Dalton and Coutts 1995). There are many occupations that necessitate people to perform activities with their upper limbs anterior to their thorax and their head in a more forward posture than is considered comfortable. Browne et al (1984) defined repetitive strain injuries as musculotendinous injuries caused by overload of particular muscle groups from repeated use or by maintenance of constrained postures, which result in pain, fatigue and a decline in work performance. Telecommunications assembly, mechanical assembly, manual sewing, data processing and keyboard operation are among the more common occupational activities that give rise to repetitive strain injuries. Leisure activities such as playing musical instruments, video games, knitting and marathon running have also been noted to lead to repetitive strain injuries (Browne et al 1984, Hutson 1997).

Dalton and Coutts (1995) suggested that the effect of gravitational forces might contribute towards a head forward posture. The line of gravity relative to the head passes through the external auditory meatus, posterior to the coronal suture and through the odontoid process. Since this line falls anterior to the transverse axis for sagittal motion of the head, a flexion movement of the head on the neck is created. The combination of this flexion movement and the habitual use of flexed postures may gradually facilitate the adoption of a more anteriorly placed neutral head posture, since this would provide the upper cervical extension necessary to realign the bipupilary plane with the horizontal. Darnell (1983) proposed that abnormal forward head postures occur due to the interaction of genetic and environmental factors. Innate genetic factors dictate to a large extent the basic body type and musculoskeletal configuration with which a person is endowed.

Muscles are sensitive labile tissues that constantly mirror changes in all parts of the motor system. One of the important functions of the cervical spine is to counterbalance the head against the force of gravity. It supports the head and allows movement of the head and neck. This requires precise adjustments and co-ordinated muscle activity (Janda 1988). In the head forward posture, the head acts as a lever arm causing a torque at the base of the cervical spine thereby increasing stress on the supporting structures (Kendall et al 1993). A muscle that functions inefficiently over a prolonged period is susceptible to strain and spasm and can produce pain. In addition to producing pain, muscles that are required to exert additional and excessive force can perpetuate or exacerbate poor postural relationships (Braun 1991, Darling et al 1984, Darnell 1983, Gossman et al 1992, Greigel-Morris et al 1992, Harrison et al 1996, Kendall et al 1993).

The gradual adoption of a more anteriorly placed natural head posture and its associated increase in upper cervical extension may facilitate shortening of the suboccipital connective tissues and muscles. Maintenance of muscle and connective tissues in a shortened position has been shown to cause a decrease in extensibility and an increased resistance to stretching (Frank et al 1985, St Pierre and Gardiner 1987). A head forward posture creates a state of musculoskeletal imbalance. Muscle imbalance describes the situation where some muscles become weak while others become tight losing their extensibility. In the proximal part of the body the pectoral major and minor, upper trapezius, levator scapulae and sternocleidomastoid tend to develop tightness. Masseter, temporalis, digastric and the suboccipital muscles (recti and oblique muscles) also tend to become tight. Muscles that are prone to hypotonia, inhibition and developing weakness are the deep cervical flexors, suprahyoid, myohyoid and the lower stabilisers of the scapula (serratus anterior, rhomboids, middle and lower trapezuis). The tendency for some muscles to develop weakness or tightness does not occur randomly rather typical muscle imbalance patterns or syndromes can be predicted. The above pattern is described as the “proximal” or “shoulder crossed” syndrome. Topographically, when the weakened and shortened muscles are connected they form a cross. This pattern of muscle imbalance and altered posture is likely to stress both the cervicocranial and cervicothoracic junctions (Janda 1988).

Shoulder posture is influenced by the resting position and status of the muscles that have attachments to both the cervical spine and the shoulder complex. Maintaining a chronic position of scapula protraction can create a stretch weakness in the scapula musculature and reduce the proximal support and stability needed for good upper quadrant posture (Kadir et al 1981). The angle of the glenoid fossa is altered and the stability of the glenohumeral joint is decreased with a protracted shoulder posture (Janda 1988). The inability to control the movement of the scapula during activities involving the upper limb frequently accompanies the development of shoulder and upper limb pain and pathology (Mottram 1997).

In addition to the affect on muscle and soft tissue, posture influences the relationship of bony structures in the vertebral column. The altered mechanics associated with head forward posture may lead to excessive compression of the facet joints and posterior surfaces of the vertebral bodies. Joint inflexibility and nerve impingement may occur. The posterior cranial rotation of the head on the upper cervical spine may also be sufficient to compress the arteries and nerves exiting the skull suboccipitally (Ayub et al 1984, Kadir et al 1981, Lezberg 1966).

The muscles of the shoulder-neck region are also involved in defence reflexes. These reflexes are activated by stress and fear, and lead to hyperactivity of the neck-shoulder musculature, thereby influencing the dynamics of the cervical spine and shoulder joint. Neck muscles show a strong tendency to develop hypertonus and spasm and not only for the reasons mentioned above. It has been shown that neck muscles contain up to 80 percent of afferent fibres in comparison to most other striated muscles that contain approximately 50 percent. This fact may explain greater sensitivity of the neck musculature to any situation that alters the proprioceptive input from cervical structures. Joint motion restriction is such a situation (Janda 1988).

## 2.2 The effect of gender and age on posture

A number of researchers have reported postural differences between genders. Braun (1991) investigated the postural differences between asymptomatic men and women and craniofacial patients. There were twenty men and twenty women in the asymptomatic group and nine women in the symptomatic group. The mean ages of the asymptomatic men, asymptomatic women and symptomatic women were 29, 28 and 38 years respectively.

Postural differences were found between the asymptomatic men and asymptomatic women at both the head and shoulders. Shoulder posture was significantly different ($p<0,05$) in the neutral and retracted position. The asymptomatic women showed a more anterior position of the shoulder than the men did in the neutral sitting position and in the maximally retracted shoulder position. The men and women were equally anterior in their maximal protraction. Total shoulder excursion was also significantly different ($p<0,05$). The women were, therefore, more "round shouldered" than the men and showed markedly less sagittal shoulder range of motion (total shoulder excursion). Head posture was significantly different ($p<0,05$) in the protracted and the neutral position. The men held their heads in a more acute angle at rest and with protraction, indicating a more anterior position of the head in relation to the seventh cervical vertebra. The head retraction position was not significantly different ($p>0,05$). The total sagittal range of head motion (total head excursion) was significantly less ($p<0,05$) for the women, due to their decreased ability to protract.

Static postural differences were observed between the asymptomatic women and the symptomatic women. Shoulder posture was significantly different ($p<0,05$) in the protracted and retracted position. The symptomatic women were able to protract their shoulders to a greater degree but showed less ability to retract. The symptomatic women had the tendency to be more "round shouldered" in the neutral shoulder position. Head posture was significantly different ($p<0,05$) in the neutral position and in the retracted position. The symptomatic women were more protracted in neutral and showed less ability to retract their heads than the asymptomatic women. These characteristics are more consistent with a more forward head posture. Range of motion of the head and shoulders in the sagittal plane had the tendency to be greater in the asymptomatic group of women but this value was not significant.

It has been documented that most patients presenting for treatment of craniofacial disorders are women. If poor postural relationships influence the craniomandibular system, then women can be expected to demonstrate a more forward head posture and be more "round shouldered” than men. Additionally, poor postural habits maintained for a prolonged period can be expected to result in decreased flexibility and less range of motion in the sagittal movement of the neck and shoulders. The results of this study suggest postural differences between men and women that are not consistent with the postural abnormalities associated with the development and perpetuation of craniofacial disorders. Postural differences as measured in this study, therefore do not explain the disparity between men and women presenting for treatment of craniofacial disorders. The symptomatic women did exhibit the poor postural characteristics associated with craniofacial disorders to a greater degree than the asymptomatic women. Braun (1991) felt that since certain postural abnormalities of the head and neck were a distinguishing clinical feature in this patient group, head and neck posture should be evaluated in patients presenting for treatment of craniofacial disorders. She recommended that a cross-sectional, age- and gender- matched study of posture should be undertaken to fully understand the influence of posture on the development of symptoms. Braun (1991) also expressed that future research efforts should be directed at examining the predictive value of head and shoulder posture on the development of symptoms. This information might be useful for the prevention of head and neck dysfunction.

The purpose of Hanten et al’s (1991) study was to determine the effects of gender and age on the measurements of resting head posture and total head excursion in sitting, and resting head posture in standing. Their subjects’ ages ranged between of 20 and 60 years. The results of analyses of variance showed that age had no significant effect ($p>0,05$) on resting head posture and total head excursion in sitting and resting head posture in standing. Two-way analyses of variance on each of the variants showed gender to be significant ($p<0,05$) for each of the dependent variables. Across the age groups, the asymptomatic men held their heads in a more forward position in standing than the asymptomatic women while the asymptomatic women held their heads in a more forward position in sitting than the asymptomatic men. Total head excursion in sitting was greater for the asymptomatic men than the asymptomatic women across the age groups. The result of the asymptomatic women having a more forward resting head posture in sitting than asymptomatic men differed from Braun’s (1991) study but the result of the total head excursion being greater in the asymptomatic men than the asymptomatic women was similar to Braun’s (1991) study. The result of asymptomatic men having a more forward resting head posture in standing than asymptomatic women was similar to Harrison et al’s (1996) study.

Harrison et al (1996) reported that a significant difference ($p=0.03$) existed between asymptomatic males and asymptomatic females for anterior translation of the head in relationship to the ankle. The asymptomatic males had a tendency towards an increased forward head posture in relationship to the lateral malleolus. A significant difference ($p=0,001$) existed between the asymptomatic males and asymptomatic females for the craniovertebral angle, with the asymptomatic males tending to have a decreased angle in relationship to the asymptomatic females. No significant differences were found for the three generations represented. Harrison et al (1996) commented that their sample size was a limitation of this study. None of their subjects had a posture the same as the “ideal” posture proposed by Kendall et al (1970). They suggested that postural correction should be a trend in the direction of the norm for that patient’s representative population i.e. age and gender rather than attainment of the “ideal”.

Dalton and Coutts (1995) investigated the effect of age on the cervical posture in a healthy population comprising of ninety-three females and ninety-seven males. The age range selected was 22 to 66 years. The neutral head posture was significantly affected by age in both the male and the female populations (males: $p<0,01$ and females: $p<0,0001$). The neutral head posture progressed towards a more forwardly placed position with increasing age. The major changes occurred in the fourth and sixth decade in both genders ($p=0,05$). In the age span studied, the females lost 40 percent of their anteroposterior head mobility (total head excursion) and the males lost 8 percent of their anteroposterior head mobility. The females lost 24 percent of their posterior glide and 50 percent of their anterior glide while the males lost 47 percent of their posterior glide and 5 percent of their anterior glide. In the female population there was a significant inter-dependent relationship between the subjects’ anteroposterior mobility and their neutral head posture. The researchers concluded that with advancing age, the anteroposterior range of head motion within the female population declined in association with a more forwardly positioned neutral head posture. No such relationship was found in the male population. Dalton and Coutts (1995) proposed that an increased resistance to the combined movement of retraction and upper cervical flexion might be the result of the deep cervical flexors being inhibited and weakened and unable to offer a counter-balancing force to the overactive shortened suboccipital muscles.

The findings of Dalton and Coutts’ (1995) study are in agreement with those of Ten Have and Eulderink (1981) and O’Driscoll and Tomenson (1982). Ten Have and Eulderink (1981) demonstrated that the mean of total head excursion in the sagittal plane decreased steadily from the age of 35-44 years onwards. Similarly O’Driscoll and Tomenson (1982) found that the most significant decline in cervical mobility in the sagittal plane occurs during the fourth and seventh decade.

Dalton and Coutts' (1995) study showed that the neutral head posture has the tendency to move slightly forward with advancing age and that some shift can be tolerated in a painless state. This does not imply that a head forward posture should not be corrected in the overall management of patients with cervical disorders.

Several authors have found age to be significant in the flexibility of other areas of the spine. Moll and Wright (1971) found a 50 percent diminution in thoracolumbar mobility between youth and old age. Fitzgerald et al (1983) confirmed the same loss of range of motion in the lumbar spine. This is in contrast to Hanten et al's (1991) study. Moll and Wright (1971) and Fitzgerald et al (1983) included age groups beyond 60 years, whereas Hanten et al's (1991) study only included subjects up to the age of 60 years. Hanten et al (1991) gave two possible explanations for their findings. They suggested that the cervical spine might retain its mobility longer than that of the thoracic and lumbar regions. Another explanation could be that one vertebral segment may become more hypermobile to compensate for the decreasing mobility of other segments, with the overall effect being an insignificant change. Hayashi et al (1987) used radiograghic images to investigate ageing changes in the cervical spine. They observed a pattern of decreased mobility at cervical vertebral levels C5-6 and C6-7, accompanied by comparatively greater mobility at the C3-4 and C4-5 vertebral levels, for a group of able-bodied subjects older than 60 years.

## 2.3 Factors affecting musculoskeletal pain

Linton (1990) examined the relationship between lifestyle, ergonomics and psychosocial workplace factors and musculoskeletal pain. A total of 22 180 employees undergoing screening examinations at their occupational health-care service filled in a series of questionnaires concerning their health, lifestyle and working situation. Thirty-one percent of the employees reported having had neck pain and 39 percent of the employees reported having had lower back pain. Psychosocial factors were consistently related to an increased risk for both neck and lower back pain. The overall psychosocial score was determined with reference to work content, workload and social support. Those experiencing a poor psychosocial work environment had, on average, more than a two-fold increase in the chance of having musculoskeletal pain requiring a health-care visit during the previous year. Ergonomic factors were also related to neck and lower back pain problems. Lifting, monotonous work tasks, vibration and uncomfortable postures produced consistently elevated odds ratios for both neck and lower back pain. Interestingly, monotonous work was more strongly related to neck pain than sitting. Lifestyle factors such as exercise, smoking, eating and drinking habits were assessed. These factors were not strongly related to the experience of neck and lower back pain. Linton (1990) suggested that lifestyle factors might not be as crucial as previously thought. However, the method of assessing lifestyle factors was rather general and might have been insensitive. The combination of exposure to both poor ergonomic and psychosocial factors produced the largest odds ratios. Consequently this study lends support to the idea that both ergonomic and psychosocial factors in the workplace might increase the risk of neck and lower back pain. Linton (1990) expressed that the results of his study should be interpreted with caution since the nature of the study did not allow for the determination of cause-effect relationships.

Mäkelä et al (1991) collected data from 1977 to 1980 of 7 217 adults aged greater than 30 years as part of the Mini-Finland Health Survey. Chronic neck syndrome was diagnosed in 9,5 percent of the men and 13,5 percent of the women. When adjusted for age and sex, the prevalence of chronic neck syndrome was strongly associated with a history of injury to the back, neck, or shoulders and with mental and physical stress at work. Among those aged 30 to 64 years, smoking, being overweight (measured by the body mass index) and parity were also significant determinants. Mäkelä et al (1991) commented that the results of their survey should be viewed as descriptive and the observed associations interpreted as end products of a complex interplay among the determinants of the disorder itself, the way it is perceived, and the consequences it has in terms of disablement and distress. Even so, it was evident that the prevalence of pain and functional impairment in the neck was not randomly distributed, but was dependent on several factors operating independently of each other. The overall result was that people with limited education, low occupational status, unpleasant working conditions and increased risk of mental and physical illnesses also carried the additional burden of an increased occurrence of chronic neck pain.

Dimberg et al (1989) carried out a research report in 1985 on the prevalence of cervicobrachial disorders in a group of workers at Volvo Aircraft Engine Division. The workers' dominant arm was most often affected and women were affected twice as often as the men. The researchers suspected that work factors might have been responsible for these observations. Dimberg et al (1989) furthered their research by analysing the correlation between cervicobrachial symptoms and some individual and work-related factors in 2 814 workers. They observed that the physical stress of the type of work was the factor most strongly correlated with ongoing cervicobrachial symptoms. Height was related to symptoms in the neck, shoulders and hands. Short stature increased the risk of symptoms. Short workers might be required to work with elevated arms and perhaps with an extended neck. Being overweight (measured by the body mass index) was, however, more strongly correlated than height and weight with cervicobrachial symptoms. Women were again shown to have almost double the rate of cervicobrachial symptoms than men. It was suggested that women are more at risk because they typically have a lower muscle force than men. Many women add to the physical stress of their job by performing household chores such as caring for children, cleaning and washing which causes an incremental rise in their total muscle strain.

## 2.4 Functional impact of musculoskeletal pain

Diener (2001) carried out a quantitative retrospective review of the functional impact on four hundred and fifty patients complaining of chronic cervicogenic headaches. Decreased productivity was reported by 89 percent of the subjects. Forty-seven percent of the subjects had to take days off work as a result of their headache episodes. Similarly, Stewart et al (1999) found that high pain frequency and intensity led to high functional disability, as portrayed in absenteeism and decreased productivity.

Diener (2001) also demonstrated that functional disability might emerge in an individual's day-to-day activities. Thirty-four percent of the subjects reported an interference with their daily chores and 32 percent with their participation in sport and recreational activities.

## 2.5 Economic impact of musculoskeletal pain

In the 1980's, epidemiological studies showed musculoskeletal pain to be a very frequent and costly disorder. People with musculoskeletal disorders were proven to be the leading "consumers" of disability pensions, sick pay and compensation insurance benefits (Linton 1990). Approximately a quarter of all sick leaves taken were related to musculoskeletal disorders (Hettinger 1985, Zuidema 1985). Mäkelä et al's (1991) study demonstrated that there was some independent association between chronic neck syndrome and disabilities, use of physician services, and use of analgesics. Linton (1990) reported in his survey that 18 percent of the employees that experienced neck pain and 16 percent of the employees that experienced lower back pain had seen a medical professional during the previous year for their symptoms.

## 2.6 Prevention of neck and shoulder musculoskeletal pain

There is some evidence to suggest that dynamic loading and stretching of the neck and shoulder muscles might prevent or relieve occupational neck and shoulder symptoms

(Levoska and Keinänen-Kiukaanniemi 1993). Niemi et al (1996) conducted a study to determine the occurrence of neck and shoulder pain and its association with static and dynamic loading of neck and shoulder muscles in various types of leisure time activities in seven hundred and fourteen high school students. Their results suggested that leisure time activities of adolescents involving dynamic loading of the upper extremity such as racquet sports may have a preventative effect on the occurrence of neck and shoulder symptoms both in adolescence and subsequently in adulthood. Dimberg et al (1989) indicated in their study that playing racquet sports decreased the risk of neck and shoulder pain in industrial workers. They suggested that apart from relieving mental stress, playing racquet sports might reduce the effects of static loading on the neck and shoulder by improving the metabolism and strengthening the muscles of this region. Researchers carried out a one-year follow-up study on a group of female office workers. They observed that the female workers experienced less neck and shoulder pain and their subjective well being improved with a holistic programme consisting of aerobic training, sub maximal dynamic muscular strengthening, ergonomic counselling and psychological intervention (Niemi et al 1996).

## 2.7 Methods of measuring head and shoulder posture

The assumed association between spinal pain and spinal posture is largely based on clinical observations, with little supporting evidence. A decision regarding normality or otherwise is often made on the clinician's experience and perception of what constitutes "normal" or "ideal" posture. The lack of an established norm prohibits objectively classifying someone as "abnormal". A reliable and efficient system for measuring head and shoulder posture is essential for clinicians to make informed decisions regarding the response of the patient to therapeutic interventions. A purely subjective assessment inhibits the ability to measure progress towards the goal (Braun and Amundson 1989, Dalton and Coutts 1995, Garrett et al 1993, Grimmer 1993, Grimmer 1997, Harrison et al 1996, Raine and Twomey 1994, Refshauge et al 1994 (ref 40)).

Various methods have been used to measure cervical and shoulder motion or position. In research settings several sophisticated methods have been used to provide objective and reliable measurements. Recent studies exist describing the use of videography or photography to quantify relationships between anatomical landmarks in the sagittal plane (Braun 1991, Dalton and Coutts 1995, Raine and Twomey 1994, Refshauge et al 1994 (ref 40)). Radiographic imaging has also been used to accurately assess head and neck posture (Smith et al 1998). These methods yield much information but are time consuming for assessing day-to-day changes in posture. Repeated measurements of the same subject with radiographic imaging would necessitate excessive exposure to roentgen rays and pose a health risk to the subject. Also it is unfortunate that these methods are expensive and some require highly technical equipment and well-trained personnel (Garrett et al 1993, Grimmer 1993, Grimmer 1997, Hanten et al 1991, Harrison et al 1996).

Early methods of measuring spinal angles from photographs were revised and described by Braun and Amundson (1989). Several authors in recent studies of head-on-neck posture have employed a similar technique to measure the various angles of the body directly on lateral photographs (Raine and Twomey 1994, Refshauge et al 1994 (ref 40), Watson and Trott 1993). Refshauge et al (1994) (ref 40) took a posterior photograph of each subject in addition to the lateral photographs. The posterior photograph was taken to determine whether the markers on the thoracic and cervical spine had deviated in the sagittal plane. Lateral deviation of a marker alters the apparent length of the marker and causes the location of the spinous process to change. To reduce measurement error the lateral photographs were excluded if the marker in the posterior photographs had deviated more than 10 millimetres.

A number of researchers have used a computer-linked digitiser to process the postural measurements of their subjects (Braun and Amundson 1989, Braun 1991, Raine and Twomey 1994, Refshauge et al 1994 (ref 40)). The surface markers and reference points for each subject were digitised from the slides and then the postural measurements were calculated. Dalton and Coutts (1995) measured the head-on–neck postures of one hundred and ninety subjects directly from their photographs. A plastic overlay, onto which the images of a protractor and twenty closely set parallel lines were photocopied, was used to measure the craniovertebral angle. A transparent ruler was then positioned between the mid-point of the marker on the tragus of the ear and the base of the marker on the spinous process of the seventh cervical vertebra, bisecting the right angle positioned at the seventh cervical vertebra. The craniovertebral angle was then measured in degrees directly from the protractor image. This method was adopted in order to prevent marking the craniovertebral angle directly on the photographs and allowing an unbiased re-measurement to be done by a second observer. Intra-examiner reliability for positioning of the subject, photography and measurements of the craniovertebral angle was conducted in this study. Twenty-nine of the hundred and ninety subjects were re-measured the following day. Inter-examiner reliability was conducted with another examiner on two aspects of the experimental procedure. Analysis revealed that for each parameter tested there was no significant difference between the trials ($P < 0{,}0001$). The intraclass correlation coefficient was not lower than 0,93 for any measurement, indicating a very high repeatability. These results demonstrated an extremely high agreement between examiners for both intra- and inter-examiner reliability.

The alignment of observed or palpated anatomical landmarks provides a basis for more in-depth evaluation of specific body regions. The results of a number of studies have shown the craniovertebral angle to be a reliable indicator of variation in head and neck posture. The spinous process of the seventh cervical vertebra can be located by sight and palpation, and it represents the distal end of the cervical lever (Braun and Amundson 1989, Darling et al 1984, Hanten et al 1991, Raine and Twomey 1994). The acromial angle has been used as an angular measure of shoulder posture. A horizontal line through the posterior acromial angle, connecting a line drawn from the spinous process of the seventh cervical vertebra to the posterior acromial angle, creates this angle. Since the position of the humerus in the glenohumeral fossa is dependent on soft tissue support as well as the skeletal relationships of the components of the shoulder girdle complex, the bicipital tendon groove may not be as accurate as the posterior angle of the acromion process for assessing changes in shoulder position in the sagittal plane. The acromion process of the scapula is palpable on the lateral surface of the shoulder. The posterior angle of the acromion process is relatively superficial, and when marked remains evident in the full range of scapular protraction and retraction (Braun and Amundson 1989, Braun 1991).

Measuring posture in the seated position will change some postural influences present in standing. It is unlikely that the results obtained in a postural assessment in sitting will be the same as those obtained in standing. An inherent error not addressed by the use of photography, videography or visual estimations is postural sway. A person attempts to maintain equilibrium in standing within the limits of stability by cycling in both an anterior – posterior and lateral direction, creating a “sway envelope”. The anterior-posterior sway of the centre of gravity has been documented to be from 1-3 centimetres. This movement provides another source of error when using single static measurements of standing posture, since the vertical relationship between the upper body and the feet is constantly changing with postural sway. It seems reasonable that the variable of postural sway may be lessened when subjects are seated, since the sway has been found to occur primarily at the hips and ankles (Harrison et al 1996).

It has been suggested that the active range of anteroposterior glide of the head and shoulders should be included in the assessment of head and shoulder posture. These ranges of movement are termed as total head excursion and total shoulder excursion respectively. Evaluation of resting posture alone provides incomplete information regarding a subject's head and neck mobility. Clinically these measurements are relevant because the reversibility of head and shoulder posture in the sagittal plane is dependent on the anteroposterior range of motion available to the individual (Braun and Amundson 1989, Goldstein et al 1984, Hanten et al 1991).

Braun and Amundson (1989) measured the head and shoulder posture in the supported sitting position of twenty asymptomatic men between the ages of 22 and 45 years. The subjects were seated in a stabilisation chair. A pelvic strap and a chest strap were used to promote a stable sitting position. Since the chest strap was positioned below the scapula, the authors felt that normal scapular movement was allowed. Each subject assumed the sequence of postural positions twice in the same day. Ten of the subjects were re-evaluated one week later. The positions were considered to be reproducible and the reliability of the computer-assisted slide digitising system was considered to be adequate for postural analysis. The mean values for the head positions were 28,5 degrees, 52 degrees, and 62,1 degrees for protraction, neutral position and retraction. The shoulder position measurements were 131,1 degrees, 98,5 degrees and 67,5 degrees for protraction, neutral position and retraction. Total head and shoulder excursions were 33,6 degrees and 63,6 degrees respectively.

No significant differences ($p>0,05$) were noted between the two measurements of head positions taken on the same day. The intraclass correlation coefficient was sufficiently high (0,78) for head protraction to suggest that this posture is reproducible and that the system was reliable in measuring this position. The neutral head position and retracted head position exhibited low intraclass correlation coefficient values (0,39 and 0,53 respectively) but the absolute mean differences were also low (5.14 and 6.51 respectively). Limited variability, as indicated by a low mean difference, can promote a low intraclass correlation coefficient value even if two measurements are, in fact, related. Therefore the neutral head position and the retracted head position were also considered to be reproducible.

No significant differences ($p>0,05$) were noted between the intraday measurements of the shoulder positions. The intraclass correlation coefficient values for the shoulder protraction, retraction and neutral shoulder position were 0,89, 0,75 and 0,85 respectively. These coefficients were sufficiently high to indicate a correlation exists between the two measurements. This suggested that the postures were predictable and that the system was reliable for measuring the three shoulder positions. A low absolute mean difference between the two measures of shoulder protraction and neutral shoulder position indicated sufficiently low variability between the measurements. The percentage error for the intraday measurement of shoulder protraction and neutral shoulder position were 5,62 and 9,51 percent respectively. The intraday measurement of shoulder retraction, however, showed a larger absolute difference and a larger percentage error (17,44 percent). This suggested that the reproducibility and reliability of measuring shoulder retraction is less than that of the other two shoulder positions.

No significant differences (p>0,05) were noted between the interday measurements of head posture. The interday intraclass correlation coefficient values were low for head protraction, neutral head position and head retraction (0.26, 0,56 and 0,02 respectively). The absolute mean differences between the measurement sessions were quite low, indicating little variability. The percentage error was low for the neutral head position (7,53 percent) and head retraction position (7,74 percent) but was higher for the head protraction position (16,86 percent). The statistics suggested that the three head positions were reproducible and reliable. The bigger percentage error for head protraction indicated limited accuracy for measuring head protraction.

No significant differences were noted between the interday measurements of shoulder posture. The intraclass correlation coefficient values demonstrated a significant correlation between the measurements from the two sessions for all the positions. The intraclass correlation coefficients for shoulder protraction, neutral shoulder position and shoulder retraction were 0,79, 0,87 and 0,71 respectively. The absolute mean difference and percentage error were low for both shoulder protraction and neutral shoulder position, indicating little variability between the measurements. The percentage error for shoulder protraction and neutral shoulder position was 7,71 and 9,09 percent respectively. Measurements of shoulder retraction showed a higher percentage error of 13,35 percent. Therefore a lower degree of accuracy might be expected when using the computer-assisted slide digitising system to measure shoulder retraction.

Refshauge et al (1994) (ref 40) felt that whilst constraining subjects with straps might enhance reliability, it is not usual physiotherapy practice. They demonstrated, in their investigation of the consistency of cervical and cervicothoracic posture of seventeen healthy subjects, that selected parameters of standing posture were highly reliable with subjects unconstrained.

Raine and Twomey (1994) investigated the reliability of a series of postural measurements of the head, shoulders and thoracic spine and identified relationships among them. Measurements were taken from photographs of subjects in comfortable erect standing and processed with computer digitising. The study consisted of thirty-nine healthy subjects (thirty-one women and eight men) between the ages of 17 and 48 years. The examiners showed that the reliability of measuring the craniovertebral angle and shoulder posture with respect to the spinous process of the seventh cervical vertebra and the coracoid process of the scapula was very good (intraclass correlation coefficients = 0,80-0,99). The mean angle for neutral head posture was 51,9 degrees. This result compared well with other recent studies describing similarly aged subjects, reporting mean values of 49-55 degrees (Braun 1991, Braun and Amundson 1989, Dalton and Coutts 1995, Watson and Trott 1993). The average neutral shoulder posture of the subjects was 132,4 degrees, representing a considerably more protracted resting position of shoulder alignment than the positions observed in Braun and Amundson's (1989) study. Braun and Amundson (1989) measured their subjects in a sitting, rather than in a standing position and they used the posterior angle of the acromion process as opposed to the coracoid process as a measure of shoulder posture. These differences in methodology might have partially accounted for the discrepancy between these results.

Studies that have investigated the resting head posture of subjects do not commonly report on the sagittal orientation of the head. Cranial rotation or anterior head alignment is a description of the position of the head relative to the Frankfurt horizontal plane. The Frankfurt horizontal plane is defined when the line joining the inferior margin of the orbit and the tragus or porion of the ear lies in the horizontal plane i.e. an angle of 180 degrees. The porion is the highest point on the upper margin of the cutaneous auditory meatus and is slightly higher than the midpoint of the tragus. If the angle is less than 180 degrees the orbit will be superior to the tragus or porion and the upper cervical spine will be relatively extended. If the angle is greater than 180 degrees the orbit will be inferior to the tragus or porion and the upper cervical spine will be relatively flexed. The use of this plane has been recommended as a means of standardising head position when determining measurements of anthropometry. Measurements of the normal inclination of the line joining the orbit to the porion have been reported as 5 degrees from the horizontal (Raine and Twomey 1994).

Raine and Twomey (1994) used the tragus of the ear as a landmark instead of the porion to measure the cranial rotation of their subjects. The average measurement was 175,6 degrees. This measurement described a slight upward (anterior) tilt of 4,4 degrees from the horizontal. The measurement of cranial rotation was found to be fairly reliable. The intraclass correlation coefficient was 0,71. Raine and Twomey (1994) commented that if they had used the porion as a landmark, their measurements would have been greater and so closer to the Frankfurt horizontal plane.

Raine and Twomey (1994) observed a number of significant correlations between the parameters they had measured. The alignment of the head was related to the curvature of the upper thoracic spine. As the head was positioned more anteriorly with respect to the trunk, there was an increase in curvature between the seventh cervical and sixth thoracic vertebral levels. This finding substantiated the clinical picture of a head forward posture co-existing with an increased thoracic kyphosis. A relationship was found between head alignment from the Frankfurt plane and shoulder alignment. As the head was tilted upwards and the upper cervical spine was placed in more extension, the shoulders were more anteriorly positioned i.e. more protracted with respect to the seventh cervical vertebra. The magnitude of the significant correlations observed was not great. While these correlations tend to support postural relationships that have been described in the literature, the authors questioned the clinical significance of their findings. Other postural characteristics that have been clinically related to a forward position of the head were not observed in their quantitative study. Extension of the upper cervical spine as measured by the angle of head alignment from the Frankfurt plane was not significantly correlated to a forward position of the head as measured by sagittal plane head alignment. The absence of a significant correlation between sagittal plane head alignment and sagittal plane shoulder alignment indicated that there was no relationship between head and shoulder positions of subjects when measured in relation to the seventh cervical vertebra. Raine and Twomey's (1994) results, therefore, did not support the observation that a forward head posture is often present in association with "rounded" shoulders. No differences were observed between the head and shoulder posture of the men and women. They only compared eight men to thirty-one women and therefore felt further investigation of the relationship of gender to posture was needed. Raine and Twomey (1994) also measured the weight and sitting height of their subjects. No relationship was found between the subjects' body size and their head and shoulder postural characteristics.

Braun (1989), Hanten et al (1991) and Raine and Twomey (1994) allowed their subjects to adopt what they considered to be their natural head posture. Dalton and Coutts (1995) and Grimmer (1993) followed the method outlined by Siersbaek-Nielsen and Solow (1982) in which the subjects continually flexed and extended their necks through a descending amplitude, before eventually assuming their most neutral, comfortably relaxed position. The subjects selected a letter on a wall chart to observe during each head sweep. This method was believed to assist with consistent horizontal placement of the head. However, Grimmer (1993) suspected that the visual cueing might have constrained some subjects from adopting their usual head-on-neck posture, particularly if their gaze was orientated downwards. Raine and Twomey (1994) commented that although it was likely that the different instructions given to subjects could have influenced the measurement of the head posture, the different protocols did not appear to have resulted in dissimilar measurements.

Dalton and Coutts (1995) took lateral photographs of their subjects in three test positions: neutral head posture, maximum head protraction and maximum head retraction. They allowed their subjects to rehearse each posture prior to taking the photograph. The authors claimed that this rehearsal ensured that the maximum positions of head protraction and retraction were achieved and it helped to relax the subject. The examiners also provided manual guidance to assist their subjects into their maximum protracted and retracted head postures.

A number of researchers have attempted to discover alternative methods of measuring posture in a clinical setting that are inexpensive, quick and simple to perform, provide immediate information and repeatable measurements. Hanten et al (1991) used a metric ruler to measure the resting head posture in standing, and resting head posture and total head excursion in sitting of two hundred and eighteen asymptomatic subjects. The metric ruler was extended from the wall perpendicularly to the reference mark. The reference mark consisted of a small piece of marked tape that was placed 3 centimetres below the lateral corner of the subject's eye, on the zygomatic arch. The authors reported high intertester reliability coefficients of 0.93-0,97.

Grimmer (1993) carried out a pilot study to determine the reliability of measuring the cervical posture of twenty healthy subjects with a Linear Excursion Measurement Device (LEMD). This device was developed in a treatment setting as a means of providing serial measurements of sagittal excursion of the head from a corrected position of maximal retraction to the usual resting position. The superior-most tip of the helix of the ear was chosen as an indicator of skull movement because it is clearly visible and moves in direct relation to the skull. It is also a point closely aligned with the ideal plumb alignment as described by Kendall et al (1993). The spinous process of the seventh cervical vertebra was chosen as the other reference point. It was a choice consistent with the method of measuring cervical posture using the craniovertebral angle. A chest strap advocated by Braun and Amundson (1989) was not employed in this study. The author was concerned that a strap might limit the true excursion movement of the seventh cervical vertebra by unduly constraining the usual relaxation of the lower cervical and upper thoracic spine. Mid-thoracic stability was confirmed by continued contact between the scapulae and the vertical backboard during all movements. The measurements were taken over four consecutive days. Statistical testing confirmed that the values obtained were consistently high.

In 1997 Grimmer furthered her research of using the Linear Excursion Measuring Device to measure cervical posture. She measured the cervical posture of four hundred and twenty-seven healthy subjects. Ninety-three subjects were re-measured one month later. The reproducibility of cervical angles measured one month later was moderately high between the test and retest measurements.

The cervical range of motion (CROM) instrument was designed to measure cervical range of motion. In addition to indicating the amount of cervical range of motion in the three cardinal planes, this instrument also has components for measuring anterior and posterior head motion. Youdas et al (1991) reported that measurements of cervical flexion, extension, and rotation and lateral flexion of sixty patients were reliable with the cervical range of motion instrument. The subjects were tested in a standardised seated position. Intraclass correlation coefficients were used to express reliability. They ranged between 0,84-0,95 for within-tester reliability and between 0,73-0,88 for between-tester reliability.

Garrett et al (1993) examined the within-tester and the between-tester reliability of the measurement of static head posture in sitting of forty patients with the use of the cervical range of motion instrument. Both the within-tester and between-tester reliability had intraclass correlation coefficients greater than 0,80. The researchers observed that when subjects protracted and retracted their head between measurements, their occiput would often make contact with the vertebra locator. This either stopped or distorted the vertical orientation of the vertebra locator. This did not affect their study but would definitely limit obtaining the range of head retraction and in turn measuring total head excursion with this device.

Harrison et al (1996) developed a method of measuring sagittal plane postural alignment of the head and shoulders in standing in relationship to the lateral malleolus, using a wall, a plumb line, a metric-based carpenter’s tri-square with a line level attached to the horizontal arm, and a goniometer with a line level attached to the horizontal arm. Two examiners performed a reliability study with fifteen asymptomatic subjects. The authors then performed a pilot study to compare means between an asymptomatic group and a symptomatic group. The asymptomatic group consisted of thirty females and eleven males between the ages of 20 and 45 years. The symptomatic group consisted of nine females and one male between the ages of 23 and 43 years. The authors measured the craniovertebral angle and cranial rotation with a goniometer. The mean craniovertebral angle of the asymptomatic and symptomatic group was 49,34 degrees and 49,43 degrees respectively. The mean cranial rotation was 161,22 degrees (anterior tilt of 18,78 degrees) for the asymptomatic group and 158,43 degrees (anterior tilt of 21,57 degrees) for the symptomatic group. The cranial rotation was calculated from the angle formed by a line connecting the tragus of the ear with the lateral corner of the eye and a horizontal line. The mean anterior tilt of the head of 18,78 degrees of the asymptomatic group was much greater than the mean anterior tilt of the head of 4,4 degrees of the asymptomatic subjects in Raine and Twomey's (1994) study. This large discrepancy in the measurement might have been as a result of the method used in the two studies being different. Raine and Twomey (1994) used a computer-linked digitiser to calculate the anterior tilt of the head from a slide of the participant while Harrison et al (1996) measured the anterior tilt of the head directly on the participant with a goniometer. Harrison et al (1996) found no significant difference ($p>0,05$) between the asymptomatic and symptomatic group for any of the variables measured. They demonstrated that their method was quantifiable and reliable for measuring the anterior translation of the head and shoulders. Despite the inherent variability of postural sway, the intraclass correlation coefficients for interrater reliability for the horizontal measurements of the head and shoulder translation were very reliable. These were 0,87 and 0,91 respectively. The interrater reliability was less for the angular measurements. The interrater reliability for the measurement of the craniovertebral angle was poor (0,34) and of the cranial rotation angle was moderate (0,68). This was as a result of the difficulty encountered in reading the goniometer while attempting to keep one goniometer arm level with the horizontal. The authors commented that their method of measuring anterior translation of the head and shoulders was practical for clinical use and that all clinicians would easily access the required equipment. They recommended that further research should be carried out to develop a more practical method of measuring the craniovertebral and cranial rotation angles.

## 2.8 Systemic variation in posture between test occasions

It has been documented that posture may be variable over time. It can be hypothesised that subjects may adopt a different posture on later measurements when they are more relaxed (Refshauge et al 1994 (ref 40)). Watson and Trott (1993) reported a high reliability for measuring the craniovertebral angle on two consecutive days. Refshauge et al (1994) (ref 40) investigated the degree of systematic variation in posture between test occasions. They showed that selected parameters of posture were highly reliable for within-trial, between-trials (within-day), and between-days. Braun and Amundson (1989) reported a comparatively poorer reliability for both intrasessions and intersessions of one week apart. They suspected that the variability might have been as a result of allowing their subjects to determine their own neutral and maximum positions.

## 2.9 The relationship between surface measurements and the position of underlying vertebrae

Johnson (1998) raised the question whether the surface measurements used in various studies actually reflect the position of the underlying vertebrae. It is essential that the relative changes within the cervical vertebrae that might accompany external postural variation be known. This is particularly the case with the upper cervical spine, which is required to undergo considerable changes in position to accommodate alterations of the head and neck posture to meet the demands of daily living and the workplace. Radiographically, the odontoid process of the second cervical vertebra and the dorsal arch of the atlas are two prominent structures within the upper cervical spine that are influenced by changes in head position. However these structures are not amenable to surface measurement, and the anatomy is extremely complicated, making it impossible to detect accurately the variation in their positions from external observations. Johnson (1998) investigated the correlation between the external measurement of head and neck posture and the anatomical position of the upper four cervical vertebrae. Measurements were taken from sagittal profile photographs and lateral cephalometric radiographs of thirty-four women aged between 17,2 and 30,5 years. The results of the study showed that no strong correlation could be established between the angles taken from the lateral cephalometric radiographs measuring the extent of upper cervical lordosis, orientation of the atlas, vertebral inclination or odontoid process tilt, and surface angles recording head and neck position.

Raine and Twomey (1994) suggested in their study that the head forward position does not necessarily co-exist with a hyperextended upper cervical spine. The results of Johnson's study (1998) endorsed this view because no single feature within the upper cervical spine could be identified in the subjects exhibiting this postural tendency. However in Johnson's study (1998), no account was taken of possible changes occurring in the lower regions of the cervical spine that might also be influencing the degree of surface head and neck inclination.

Refshauge et al (1994) (ref 41) examined several postural parameters to establish the degree to which surface measurements of cervical and upper thoracic alignment reflect the underlying vertebral body alignment. They took lateral view radiographs of twenty-four healthy volunteers aged between 21 and 42 years. The spinous processes of the volunteers' second and fourth cervical vertebrae and sixth cervical vertebra to sixth thoracic vertebra were located and marked with metal markers before the radiographs were taken. The location of the markers was agreed upon by two examiners to ensure a more accurate result. The geometric centres of the relevant vertebral bodies were located using the method described by Bryant et al (1989).

The results showed that there was a poor to good correlation between the surface and vertebral body parameters. Differences between the surface and vertebral body measurements appear to be due to a combination of factors, including the variability of the length of the spinous processes and the thickness of the overlying soft tissue. Despite the overall difference between the surface and vertebral curves, in most subjects the end points of the curves (second cervical vertebra and sixth thoracic vertebra) were closely related. This probably explains the relatively high correlation (intraclass correlation coefficient = 0,82) between the surface and vertebral cervical inclination when measured from the second thoracic vertebra instead of the seventh cervical or first thoracic vertebrae. Refshauge et al (1994) (ref 41) concluded that because the surface measurement of cervical inclination was a good predictor of vertebral body position when measured from the second cervical and second thoracic vertebrae, it might be appropriate to formulate the hypothesis that an alteration in the surface alignment will reflect a similar alteration in the vertebral alignment. Their findings do not suggest that observing spinal posture is of little clinical value, but that interpretation of clinical observations of surface contours should be made with caution. The researchers commented that with further knowledge of the relationship between surface and vertebral alignment, one would be able to identify those surface measurements that more consistently reflect vertebral alignment.

## 2.10 Use of standardised Nordic musculoskeletal questionnaires

Questionnaires have proved to be one of the most affective means of collecting data. Standardisation is necessary in the analysing and recording of musculoskeletal symptoms otherwise it is difficult to compare the results of different studies. The standardised Nordic musculoskeletal questionnaires were designed to assist in the screening of musculoskeletal disorders in an ergonomics context. The questionnaires are not meant to provide a basis for clinical diagnosis (Dickinson et al 1992, Kuorinka et al 1987).

The standardised Nordic musculoskeletal questionnaires have been used in more than a hundred different projects as well as in routine work in occupational health care services. The questionnaires have been shown to be reliable and valid. The reliability of the neck questionnaire was tested on twenty-seven women in clerical work, who answered the questionnaire twice within a 3-week interval. The percentage of disagreeing responses varied from 0 to 15 percent except for the question on the total length of time that neck symptoms had troubled the respondent during the last 12 months. The percentage disagreement was 30 percent. The validity of the neck questionnaire was tested on eighty-two women in electronics manufacturing. The questionnaire responses were compared with those obtained when a physiotherapist completed the questionnaire after a thorough interview about the subjects' medical history. The percentage of disagreement between the subjects' own responses and the physiotherapist's estimates varied from 0 to 13 percent (Dickinson et al 1992, Kuorinka et al 1987).

## 2.11 Summary of literature review

The postural characteristics cited in the literature, as being particularly relevant to pain located in the craniofacial, cervical, interscapular, shoulder and pectoral regions, and down the upper limb, is the forward head posture and protracted shoulders. Ideal posture is believed to be a state of musculoskeletal balance that involves a minimum amount of stress and strain to the body.

It has been hypothesised that the habitual use of flexed postures of the head and neck throughout life could facilitate the progression of a forward head posture. Muscles are sensitive labile tissues that constantly mirror changes in all parts of the motor system. A muscle that functions inefficiently for a prolonged period is susceptible to strain and spasm and can produce pain. A head forward posture creates a state of musculoskeletal imbalance where some muscles become weak while others become tight losing their extensibility.

Shoulder posture is influenced by the resting position and status of the muscles that have attachments to both the cervical spine and the shoulder complex. Maintaining a chronic position of scapula protraction can create a stretch weakness in the scapula musculature and reduce the proximal support and stability needed for good upper quadrant posture.

In addition to the effect on muscle and soft tissue, posture influences the relationship of bony structures in the vertebral column. The altered mechanics associated with head forward posture may lead to excessive compression of the facet joints and posterior surfaces of the vertebral bodies. Joint inflexibility and nerve impingement may occur.

Some researchers have reported that gender and age have an effect on posture. Postural differences observed between males and females vary across the studies. The results of a number of studies showed that the most significant decline in cervical mobility in the sagittal plane occurs during the fourth and seventh decade. Researchers have suggested that the natural head posture has the tendency to move slightly forward with advancing age and that some shift can be tolerated in a painless state.

Psychosocial workplace factors and ergonomics have been related to an increased risk of musculoskeletal pain. Lifting, monotonous work tasks, vibration and uncomfortable working postures have been shown to cause consistently elevated odds ratios for both neck and back pain. The combination of exposure to poor ergonomic and psychosocial factors produced the largest odds ratios.

Height has been related to cervicobrachial symptoms. Workers with a short stature might be required to work with elevated arms and an extended neck and therefore more at risk of developing cervicobrachial symptoms. Being overweight (measured by body mass index) was more strongly correlated than height and weight with cervicobrachial symptoms. A correlation was observed between cervicobrachial symptoms and the workers' hand dominance. A disparity between the number of men and women presenting for treatment of cervicobrachial symptoms has been reported. It was suggested that women are more at risk because they typically have a lower muscle force than men. Many women add to the physical stress of their job by performing household chores such as caring for children, cleaning and washing which might cause an incremental rise in their total muscle strain.

Musculoskeletal pain can lead to a high level of functional disability, as portrayed in absenteeism and decreased work productivity. Epidemiological studies have shown musculoskeletal pain to be a very frequent and costly disorder. People with musculoskeletal disorders were proven to be the leading "consumers" of disability pensions, sick pay and compensation insurance benefits.

Researchers have observed that workers experienced less neck and shoulder pain and their subjective well being improved with a holistic programme consisting of aerobic training, sub maximal dynamic muscular strengthening, ergonomic counselling and psychological intervention. It has been suggested that leisure time activities of adolescents involving dynamic loading of the upper extremity such as racquet sports may have a preventive effect on the occurrence of neck and shoulder symptoms both in adolescence and subsequently in adulthood.

Various methods have been used to measure cervical and shoulder motion or position. A reliable and efficient system for measuring head and shoulder posture is essential for clinicians to make informed decisions regarding the response of the patient to therapeutic interventions. In research settings several sophisticated methods have been used to provide objective and reliable measurements. These include videography, photography and radiographic imaging. A number of researchers have utilised a computer-linked digitiser to process the postural measurements of their subjects. Other researchers have calculated postural measurements directly from photographs using a plastic overlay, onto which the images of a protractor and twenty closely set parallel lines were photocopied. This simple method was shown to be highly reliable.

The alignment of observed or palpated anatomical landmarks provides a basis for more in-depth evaluation of specific body regions. The results of a number of studies have shown the craniovertebral angle to be a reliable indicator of variation in head and neck posture. The angle between a horizontal line transecting the spinous process of the seventh cervical vertebra and connecting the tragus of the ear with the spinous process of the seventh cervical vertebra is called the craniovertebral angle. The acromial angle has been used as an angular measure of shoulder posture. A horizontal line through the posterior acromial angle, connecting a line drawn from the spinous process of the seventh cervical vertebra to the posterior acromial angle, creates this angle. The sagittal orientation of the head can be measured by using the cranial rotation angle. A line joining the inferior margin of the orbit with the tragus or porion of the ear and the horizontal line forms the cranial rotation angle. It has been recommended to include the active range of anteroposterior glide of the head and shoulders in the assessment of head and shoulder posture. Clinically these measurements are relevant because the reversibility of head and shoulder posture in the sagittal plane is dependent on the anteroposterior range of motion available to the individual.

Many researchers have attempted to discover alternative methods of measuring posture in a clinical setting that are inexpensive, quick and simple to perform, provide immediate information and repeatable measurements. Some of these methods have included the use of a metric ruler, Linear Excursion Measurement Device, cervical range of motion instrument, carpenter’s tri-square and goniometer.

It has been documented that posture may be variable over time. It can be hypothesised that subjects may adopt a different posture on later measurements when they are more relaxed. To the contrary, a number of authors have reported a high reliability between test occasions for their methods of measuring posture. The question has been raised whether the surface measurements used in various studies actually reflect the position of the underlying vertebrae. Differences between the surface and vertebral body measurements appear to be due to a combination of factors, including the variability of the length of the spinous processes and the thickness of the overlying soft tissue. Despite the overall difference between the surface and vertebral curves, researchers have observed that the end points of cervical and cervicothoracic curves (second cervical vertebra and sixth thoracic vertebra) appeared to be closely related. Their findings do not suggest that observing spinal posture is of little clinical value, but that interpretation of clinical observations of surface contours should be made with caution.

Numerous researchers have reported that none of their subjects had a posture the same as the "ideal" posture that was proposed by researchers in the 1970's. It has been suggested that postural correction should be a trend in the direction of the norm of the individual's representative population i.e. age and gender rather than the attainment of the "ideal". Further cross-sectional, age- and gender-matched studies of posture have been recommended to fully understand the influence of posture on the development of symptoms.

# 3 METHODOLOGY

## 3.1 Introduction

This chapter describes the study sample and design. A detailed description of the instruments and procedures used for data collection is provided. The main methods used for data reduction and analysis are given.

## 3.2 Study design

A cross-sectional study was conducted to obtain the necessary data for analysis

## 3.3 Ethical clearance

The Ethics and Postgraduate Committees of the University of the Witwatersrand approved the research protocol (protocol number M 970733).

## 3.4 Sample

A sample of convenience was used. Thirty-seven people participated in the study. The experimental group consisted of nineteen patients (three males and sixteen females) who were seeking treatment for chronic cervical pain at a private physiotherapy practice. The control group consisted of eighteen “healthy” volunteers (four males and fourteen females).

The age of the experimental group ranged between 18 and 33 years and that of the control group ranged between 20 and 33 years. The average age of both groups was 25 years. People over the age of 35 years were not accepted for the study in order to reduce the possible effect that age has on cervical and shoulder posture.

Patients with a history of severe trauma, such as a fracture, neurological injury involving the spine, shoulders or head, or a recent whiplash injury (i.e. less than two years ago) were excluded from the study. A criterion for inclusion in the experimental group was a six-month history of cervical pain. Pain lasting for six months or more is classified as chronic pain (Braun 1991).

A “healthy” volunteer was defined as someone who at the time of testing had no pain and did not have a past history of neck or back pain that had lasted for more than four days (Braun 1991, Harrison et al 1996).

## 3.5 Development of the questionnaire

The questionnaire (appendix A) was drawn from the standardised Nordic neck questionnaire and the questionnaires used in the studies carried out by Griegel–Morris et al (1992) and Niemi et al (1996). Questions 1 to 6, 8 and 10 to 12 were drawn from the standardised Nordic neck questionnaire. The body chart and questions 7 and 9 were drawn from the questionnaire in Griegel-Morris et al’s (1992) study. Regions E (anterior and posterior head), F1 and F2 (left and right upper limbs) were added to the body chart in order to include the possibility of referred cervical pain. Question 13 was drawn from Niemi et al’s (1996) questionnaire.

Leisure time activities documented by the participants were later categorised by the researcher into “static” and “active” activities e.g. aerobic as an “active” and reading as a “static” activity. The researcher also rated the frequencies of the leisure time activities documented by the participants on a scale of 0-9 as follows (hpm = hours per month):

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | (nil hpm); | 3 | (21-30 hpm); | 6 | (51-60 hpm); | 9 | (> 81 hpm). |
| 1 | (1-10 hpm); | 4 | (31-40 hpm); | 7 | (61-70 hpm); | | |
| 2 | (11-20 hpm); | 5 | (41-50 hpm); | 8 | (71-80 hpm); | | |

The participants’ body mass index (BMI) was calculated (Mäkelä et al 1991, Niemi et al 1996, Raine and Twomey 1994). Body mass index is measured in kilograms per square metre (kg/m$^2$). Body mass index ranges are as follows: below weight (<18,5 kg/m$^2$), healthy weight (18,5-24,9 kg/m$^2$), overweight (25-29,9 kg/m$^2$), obese (30-39,9 kg/m$^2$) and severely obese (>40 kg/m$^2$).

## 3.6 Pilot study

A pilot study was initially conducted on four participants (three experimental and one control) to determine the reliability of the procedures used in this study. The measurements described under 3.7 were done three times with one day between measurements. Measurements were found to be within 0.5 of a degree. No adaptations were made to the questionnaire or the method of measuring head and shoulder posture. The four participants were included in the main study.

## 3.7 Procedure

The participants read and signed a consent form (appendix B) and completed a questionnaire (appendix A) prior to the collection of the rest of the data. The questionnaire contained questions concerning: gender, age, occupation, working hours per week, height (cm), weight (kg), hand dominance, history of skeletal disorders and previous trauma, frequency and severity of pain experienced in the head, neck and shoulder regions and type and frequency of leisure time activities. The researcher was available if the participant required assistance to complete the questionnaire.

Static postural data was collected via lateral photographs taken with a camera mounted on a tripod (Braun 1991, Braun and Amundson 1989, Dalton and Coutts 1995). A vertical plumb line was placed behind the participant to calculate the true horizontal (Dalton and Coutts 1995). The participants sat in a standard high back chair with their buttocks positioned at the back of the chair, knees flexed to approximately 90 degrees and feet flat on the floor. The participants' arms hung loosely at their sides. A chest strap was positioned around the participants' thorax to promote a stable sitting posture. The strap was positioned below the scapula so that normal scapular movement was allowed (Braun 1991, Braun and Amundson 1989).

The following anatomical landmarks were identified: the lateral corner of the eye, tragus of the ear, spinous process of the seventh cervical vertebra and the posterior acromial angle (Braun 1991, Braun and Amundson 1989, Dalton and Coutts 1995, Raine and Twomey 1994, Watson and Trott 1993). A spike was taped to the skin overlying the spinous process of the seventh cervical vertebra so as to project posteriorly at 90 degrees (Braun 1991, Braun and Amundson 1989, Dalton and Coutts1995). The posterior acromial angle was marked with a 1-centimetre square of white tape.

In order for the participants to maintain the desired postures, they were instructed to visually focus directly ahead on the wall. This was done in an attempt to minimise the participants' tendency towards flexing or extending their cervical spines while assuming the various postures (Braun 1991, Braun and Amundson 1991). Additionally, the participants were instructed to maintain constant thoracic pressure on the backrest of the chair during testing to promote a static trunk posture (Braun 1991, Braun and Amundson 1989, Dalton and Coutts1995).

The following five static postural positions were defined and assessed:

1. Neutral or natural head and shoulder posture
2. Maximal head protraction
3. Maximal head retraction
4. Maximal shoulder protraction
5. Maximal shoulder retraction

1. <u>Neutral or natural head and shoulder posture.</u>

The participants were positioned as described above and instructed to "keep their eyes focused directly ahead". Three different angles were measured: craniovertebral angle, cranial rotation angle and angular measurement of shoulder posture (Figure1). The craniovertebral angle was measured by a line connecting the tragus and the tip of the spinous process of the seventh cervical vertebra, transecting the horizontal line. The craniovertebral angle assessed the relative forward position of the participants' heads (Braun 1991, Braun and Amundson 1989, Dalton and Coutts 1991, Raine and Twomey 1994, Watson and Trott 1993). The cranial rotation angle was measured by a line connecting the tragus of the ear and the lateral corner of the eye, transecting the horizontal line (Raine and Twomey 1994). The cranial rotation angle assessed the sagittal orientation of the participants' heads. The angular measurement of shoulder posture was measured from a line connecting the spinous process of the seventh cervical vertebra and the posterior acromial angle, transecting the horizontal line (Braun 1991, Braun and Amundson 1989). This angle assessed the participants' shoulder position in the saggital plane.

2. <u>Maximal head protraction</u>

The participants were instructed to "keep their eyes focused directly ahead and move their heads as far forwards as possible" while maintaining constant thoracic pressure against the backrest of the chair. The craniovertebral angle was reassessed (Braun 1991, Braun and Amundson 1989, Dalton and Coutts 1995).

3. Maximal head retraction

The participants were instructed to “keep their eyes focused directly ahead and move their heads as far backwards as possible” while maintaining constant thoracic pressure against the backrest of the chair. The craniovertebral angle was reassessed (Braun 1991, Braun and Amundson 1989, Dalton and Coutts 1995).

4. Maximal shoulder protraction

The participants were instructed to “keep their eyes focused directly ahead and to bring their shoulders as far forwards as possible” into a position of maximal scapular protraction, while maintaining constant thoracic pressure against the backrest of the chair. The participants were discouraged from rotating their glenohumeral joints. The angular measure of shoulder posture was reassessed (Braun 1991, Braun and Amundson 1989, Dalton and Coutts 1995).

5. Maximal shoulder retraction

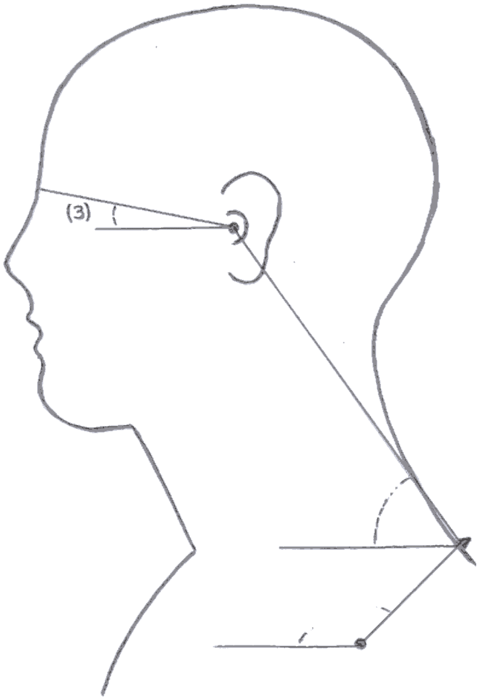
The participants were instructed to “keep their eyes focused directly ahead and to bring their shoulder blades as close together as possible” into a position of maximal scapular retraction, while maintaining constant thoracic pressure against the backrest of the chair. The participants were discouraged from rotating their glenohumeral joints. The angular measure of shoulder posture was reassessed (Braun 1991, Braun and Amundson 1989, Dalton and Coutts 1995).

This sequence of static postural positions was photographed on the participants’ left and right sides to assess any postural variances between the sides. The participants were allowed to rehearse of each postural position prior to taking the photographs to minimize error (Dalton and Coutts 1995). The postural positions were performed within a pain free range of movement. The experimental group completed the procedures of the study prior to receiving any physiotherapy treatment so as not to influence any of the measurements.

A transparent grid was placed over the photographs. A protractor and a ruler were used to measure the various angles from the photographs (Dalton and Coutts 1995). Each set of photographs was re-measured by the researcher on three different occasions. The mean of these measurements was then calculated.

The participants' active range of anteroposterior glide (total excursion) of their heads and shoulders were also assessed (Braun 1991, Braun and Amundson 1989, Dalton and Coutts 1995).

Total head excursion = maximum head retraction – maximum head protraction
Total shoulder excursion = maximum shoulder protraction – maximum shoulder retraction




(1) Craniovertebral angle
(2) Angular measurement of shoulder
(3) Cranial rotation

Figure I: Schematic diagram of the anatomical landmarks and angular measurements of head and shoulder posture

## 3.8 Statistical analysis of the data

The experimental and control groups were compared with respect to their frequency distributions over the categories of the demographic variables and static postural positions using the Fisher's exact test. Testing was done at the 0,05 level of significance. A descriptive comparison was made of the relationship between the frequency and severity of pain in various body regions and selected postural measurements of the experimental group.

Frequency and severity were at four levels i.e. never, rarely (1 time per month or less), occasionally (2-3 times per month) and frequently (1 or more times per week) for frequency and none (0), mild (1-3), moderate (4-7) and severe (8-10) for severity. The means of the selected postural measurements of the lowest level of frequency and severity of pain were compared with those of the highest level of frequency and severity of pain.

The following body regions and selected postural measurements of the experimental group were investigated:

(1) The extremes of frequency and severity of left posterior cervical pain (region B1) and the measurements of left neutral head posture, left maximum head protraction, left maximum head retraction, left total head excursion and left cranial rotation.

(2) The extremes of frequency and severity of anterior and posterior head pain (region E) and the measurements of left neutral head posture, left maximum head protraction, left maximum head retraction, left total head excursion and left cranial rotation.

(3) The extremes of frequency and severity of left scapular and shoulder pain (region C1) and the measurements of left neutral shoulder posture, left maximum shoulder protraction, left maximum shoulder retraction and left total shoulder excursion.

(4) The extremes of frequency and severity of interscapular pain (region D) and the measurements of left neutral shoulder posture, left maximum shoulder protraction, left maximum shoulder retraction and left total shoulder excursion.

(5) The extremes of frequency and severity of right posterior cervical pain (region B2) and the measurements of right neutral head posture, right maximum head protraction, right maximum head retraction, right total head excursion and right cranial rotation.

(6) The extremes of frequency and severity of anterior and posterior head pain (region E) and the measurements of right neutral head posture, right maximum head protraction, right maximum head retraction, right total head excursion and right cranial rotation.

(7) The extremes of frequency and severity of right scapular and shoulder pain (region C2) and the measurements of right neutral shoulder posture, right maximum shoulder protraction, right maximum shoulder retraction and total shoulder excursion.

(8) The extremes of frequency and severity of interscapular pain (region D) and the measurements of right neutral shoulder posture, right maximum shoulder protraction, right maximum shoulder retraction and right total shoulder excursion.

# 4 RESULTS

## 4.1 Demographic variables

### 4.1.1 Gender

Table 1: Distribution of gender

| Gender | Experimental | Control | Total |
|---|---|---|---|
| Female | 16 (84,21%) | 14 (77,78%) | 30 (81,08%) |
| Male | 3 (15,79%) | 4 (22,22%) | 7 (18,92%) |
| Total | 19 (100%) | 18 (100%) | 37 (100%) |

There was no significant difference (p=0,693) in the distribution of females and males within the experimental and control groups. It was not within the scope of the study to investigate postural differences between genders.

### 4.1.2 Occupation

Table2: Occupations

| Occupation | Experimental | Control |
|---|---|---|
| Clerk | 2 | 0 |
| Commercial artist | 1 | 0 |
| Consultant | 4 | 1 |
| Lecturer | 0 | 3 |
| Machine minder | 0 | 1 |
| Manager | 1 | 1 |
| Personal assistant | 1 | 0 |
| Physiotherapist | 4 | 5 |
| Receptionist | 2 | 0 |
| Seamstress | 1 | 0 |
| Student | 1 | 6 |
| Teacher | 2 | 1 |
| Total | 19 | 18 |

The researcher was advised by the statistician that it was not possible to statistically analyse the occupations of the experimental and control groups because the sample size of the study was small and the diversity of their occupations was great.

### 4.1.3 Hours worked per week

Table 3: Hours worked per week

| Hrs worked / week | Experimental | Control | Total |
|---|---|---|---|
| 40 hrs or less | 11 (57,89%) | 11 (61,11%) | 22 (59,46%) |
| More than 40 hrs | 8 (42,11%) | 7 (38,89%) | 15 (40,54%) |
| Total | 19 (100%) | 18 (100%) | 37 (100%) |

There was no significant difference (p=1,000) in the number of hours worked per week between the experimental and control groups.

### 4.1.4 Body mass index (kg/m²)

Table 4: Body mass index (kg/m²)

| BMI | Experimental | Control | Total |
|---|---|---|---|
| Below | 0 (0%) | 1 (5,56%) | 1 (2,70%) |
| Healthy | 14 (73,68%) | 15 (83,33%) | 29 (78,38%) |
| Over | 2 (10,53%) | 1 (5,56%) | 3 (8,11%) |
| Obese | 3 (15,79%) | 1 (5,56%) | 4 (10,81%) |
| Total | 19 (100%) | 18 (100%) | 37 (100%) |

There was no significant difference (p=0,694) in the body mass index between the experimental and control groups.

### 4.1.5 Hand dominance

Table 5: Hand dominance.

| Hand dominance | Experimental | Control | Total |
|---|---|---|---|
| Right | 19 (100%) | 16 (88,89%) | 35 (94,59%) |
| Left | 0 (0%) | 2 (11,11%) | 2 (5,41%) |
| Total<br>Total | 19 (100%) | 18 (100%) | 37 (100%) |

There was no significant difference (p=0,230) in hand dominance between the experimental and control group.

### 4.1.6 History of skeletal disorders

Table 6: History of skeletal disorders

| History of disorder | Experimental | Control | Total |
|---|---|---|---|
| Yes | 2 (10,53%) | 2 (11,10%) | 4 (21,63%) |
| No | 17 (89,47%) | 16 (88,90%) | 33 (78,37%) |
| Total | 19 (100%) | 18 (100%) | 37 (100%) |

There was no significant difference (p=1,000) in the history of skeletal disorders between the experimental and control groups. Two participants (10,53 percent) of the experimental group reported a history of skeletal disorders; one of a spina bifida occulta of her fourth and fifth lumbar vertebral levels and the other of a laminectomy of her fifth lumbar vertebral level. Two participants (11,11 percent) of the control group reported a history of skeletal disorders; one had previously suffered from Scheuermann's disease and the other had a history of a mild scoliosis.

### 4.1.7 History of previous trauma to the cervical region

Table 7: History of previous trauma to the cervical region

| History of trauma | Experimental | Control | Total |
|---|---|---|---|
| Yes | 4 (21,05%) | 2 (11,11%) | 6 (16,22%) |
| No | 15 (78,95%) | 16 (88,89%) | 31 (83,78%) |
| Total | 19 (100%) | 18 (100%) | 37 (100%) |

There was no significant difference (p=0,660) in the history of previous trauma to the cervical region between the experimental and control groups. Four of the participants (three experimental and one control) had experienced whiplash injuries in motor vehicle accidents more than two years ago.

4.1.8 Effect on other activities of daily living (e.g. housework, leisure time activities) per annum

Table 8: Effect on other activities of daily living per annum

| Effect on ADL | Experimental | Control | Total |
|---|---|---|---|
| 0 days | 6 (31,58%) | 16 (88,89%) | 22 (59,46%) |
| 1-7 days | 11 (57,89%) | 2 (11,11%) | 13 (35,14%) |
| 8-30 days | 1 (5,26%) | 0 (0%) | 1 (2,70%) |
| > 30 days | 1 (5,26%) | 0 (0%) | 1 (2,70%) |
| Total | 19 (100%) | 18 (100%) | 37 (100%) |

The experimental group's ability to carry out other activities of daily living was significantly affected (p=0,001) by cervical pain.

4.1.9 Time spent per month on leisure time activities

Table 9: Time spent per month on "static" leisure time activities

| Hours per month | Experimental | Control | Total |
|---|---|---|---|
| Nil hours | 0 (0%) | 1 (5,56%) | 1 (2,70%) |
| 1-10 hours | 2 (10,53%) | 4 (22,22%) | 6 (16,22%) |
| 11-20 hours | 3 (15,79%) | 4 (22,22%) | 7 (18,92%) |
| 21-30 hours | 3 (15,79%) | 2 (11,11%) | 5 (13,51%) |
| 31-40 hours | 5 (26,32%) | 1 (5,56%) | 6 (16,22%) |
| 41-50 hours | 0 (0%) | 2 (11,11%) | 2 (5,41%) |
| 51-60 hours | 4 (21,05%) | 2 (11,11%) | 2 (16,22%) |
| 61-70 hours | 0 (0%) | 1 (5,56%) | 1 (2,70%) |
| 71-80 hours | 2 (10,53%) | 1 (5,56%) | 3 (8,11%) |
| > 81 hours | 0 (0%) | 0 (0%) | 0 (0%) |
| Total | 19 (100%) | 18 (100%) | 37 (100%) |

Table 10: Time spent per month on “active” leisure time activities

| Hours per month | Experimental | Control | Total |
|---|---|---|---|
| Nil hours | 5 (26,32%) | 3 (16,67%) | 8 (21,62%) |
| 1-10 hours | 6 (31,58%) | 1 (5,56%) | 7 (18,92%) |
| 11-20 hours | 2 (10,53%) | 8 (44,44%) | 10 (27,03%) |
| 21-30 hours | 3 (15,79%) | 3 (16,67%) | 6 (16,22%) |
| 31-40 hours | 1 (5,26%) | 2 (11,11%) | 3 (8,11%) |
| 41-50 hours | 0 (0%) | 0 (0%) | 0 (0%) |
| 51-60 hours | 0 (0%) | 0 (0%) | 0 (0%) |
| 61-70 hours | 2 (10,53%) | 1 (5,56%) | 3 (8,11%) |
| 71-80 hours | 0 (0%) | 0 (0%) | 0 (0%) |
| > 81 hours | 0 (0%) | 0 (0%) | 0 (0%) |
| Total | 19 (100%) | 18 (100%) | 37 (100%) |

The diversity of leisure time activities mentioned by the participants was great. These activities were categorised into “active” and “static” groups in order to be statistically analysed. There was no significant difference (p=0,426) between the two groups for the time spent on “static” leisure time activities. There was a tendency (p=0,118) for the control group to devote a greater number of hours to “active” leisure time activities than the experimental group.

## 4.2 Presentation of measurements of the static postural positions and total head and shoulder excursions (measured in degrees)

Table 11: Measurements of the static postural positions and total head and shoulder excursions of the experimental and control groups (measured in degrees)

| Variable | Exp mean | Exp Std Dev | Control mean | Control Std Dev |
|---|---|---|---|---|
| **Lnhp** | 48,63 | 5 | 51,89 | 7 |
| **Lmhp** | 31,11 | 5 | 34,44 | 6 |
| **Lmhr** | 55,79 | 6 | 62,17 | 6 |
| **Lthe** | 24,68 | 8 | 27,72 | 6 |
| **Lcr** | 164,16 | 6 | 162,89 | 5 |
| **Lnsp** | 104,53 | 12 | 108,44 | 14 |
| **Lmsp** | 124,42 | 14 | 124,61 | 14 |
| **Lmsr** | 79,68 | 14 | 75,06 | 12 |
| **Ltse** | 44,74 | 15 | 49,56 | 16 |
| **Rnhp** | 50,74 | 6 | 51,67 | 6 |
| **Rmhp** | 32,89 | 5 | 33,83 | 5 |
| **Rmhr** | 56,63 | 8 | 61,44 | 6 |
| **Rthe** | 23,74 | 9 | 27,61 | 6 |
| **Rcr** | 164,37 | 6 | 161,50 | 5 |
| **Rnsp** | 100,84 | 14 | 106,39 | 12 |
| **Rmsp** | 124,68 | 15 | 127,00 | 11 |
| **Rmsr** | 78,21 | 17 | 75,22 | 18 |
| **Rtse** | 46,47 | 18 | 51,78 | 19 |

Key: L denotes Left and R denotes Right

nhp neutral head posture
mhp maximum head protraction
mhr maximum head retraction
the total head excursion
cr cranial rotation
nsp neutral shoulder posture
msp maximum shoulder protraction
msr maximum shoulder retraction
tse total shoulder excursion

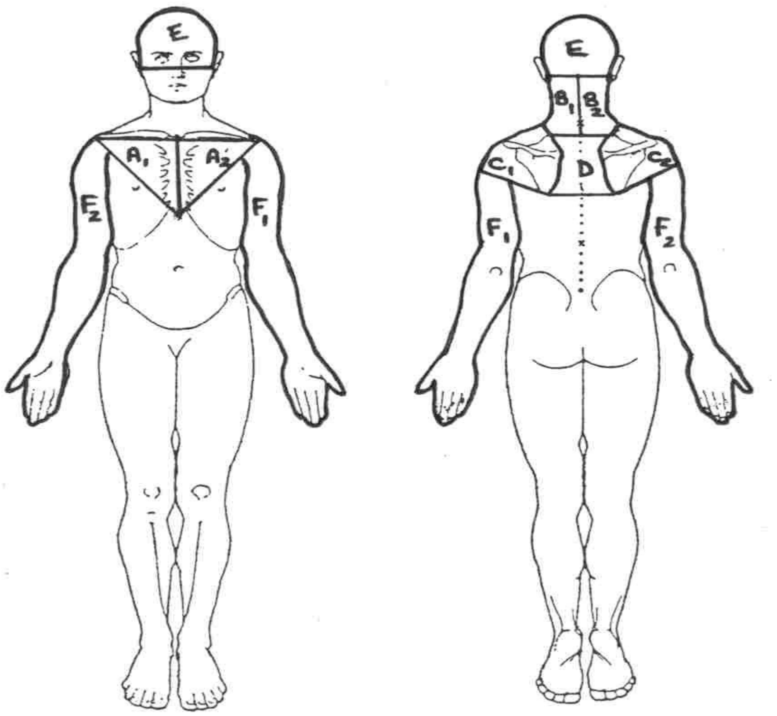
Table 12: Measurements of the static postural positions and total head and shoulder excursions of the experimental and control groups and other studies (measured in degrees)

| **Variable** | **Exp mean** | **Control mean** | **Braun 89 asym male mean** | **Braun 91 asym male mean** | **Braun 91 asym female mean** | **Braun 91 sym female mean** | **Dalton 95 asym male mean** | **Dalton 95 asym female mean** | **Raine 94 asym mean** |
|---|---|---|---|---|---|---|---|---|---|
| **Lnhp** | 48,63 | 51,89 | 51,97 | 51,89 | 55,36 | 48,23 | 50,60 | 49,50 | 51,90 |
| **Lmhp** | 31,11 | 34,44 | 28,48 | 27,08 | 33,20 | 32,34 | 30,60 | 32,80 | |
| **Lmhr** | 55,79 | 62,17 | 62,09 | 61,78 | 63,59 | 59,28 | 62,70 | 63,00 | |
| **Lthe** | 24,68 | 27,72 | 33,62 | 34,70 | 30,39 | 30,39 | 31,90 | 30,20 | |
| **Lcr** | 164,16 | 162,89 | | | | | | | 175,60 |
| **Lnsp** | 104,53 | 108,44 | 98,53 | 100,75 | 112,89 | 122,82 | | | |
| **Lmsp** | 124,42 | 124,61 | 131,08 | 131,98 | 135,19 | 140,15 | | | |
| **Lmsr** | 79,68 | 75,06 | 67,49 | 68,33 | 88,95 | 102,57 | | | |
| **Ltse** | 44,74 | 49,56 | 63,58 | 63,65 | 46,24 | 37,57 | | | |
| **Rnhp** | 50,74 | 51,67 | | | | | | | |
| **Rmhp** | 32,89 | 33,83 | | | | | | | |
| **Rmhr** | 56,63 | 61,44 | | | | | | | |
| **Rthe** | 23,74 | 27,61 | | | | | | | |
| **Rcr** | 164,37 | 161,50 | | | | | | | |
| **Rnsp** | 100,84 | 106,39 | | | | | | | |
| **Rmsp** | 124,68 | 127,00 | | | | | | | |
| **Rmsr** | 78,21 | 75,22 | | | | | | | |
| **Rtse** | 46,47 | 51,78 | | | | | | | |

Key: L denotes Left and R denotes Right

nhp neutral head posture
mhp maximum head protraction
mhr maximum head retraction
the total head excursion
cr cranial rotation
nsp neutral shoulder posture
msp maximum shoulder protraction
msr maximum shoulder retraction
tse total shoulder excursion

## 4.3 The frequency and severity of pain experienced by the experimental group




Key:

| | |
|---|---|
| A1 | right pectoral region |
| A2 | left pectoral region |
| B1 | left posterior cervical region |
| B2 | right posterior cervical region |
| C1 | left scapular and shoulder region |
| C2 | right scapular and shoulder region |
| D | interscapular region |
| E | anterior and posterior head region |
| F1 | left upper limb |
| F2 | right upper limb |

Scales:

| | | |
|---|---|---|
| Frequency | N = never | |
| | R = rarely | (1 time per month or less) |
| | O = occasionally | (2 – 3 times per month) |
| | F = frequently | (1 or more times per week) |
| Severity | 0 = none | |
| | 1 – 3 = mild | |
| | 4 – 7 = moderate | |
| | 8 – 10 = severe | |

Figure 2: Regions of the body chart

Table 13: Summary of the frequency of pain experienced in the regions of the body chart of the experimental group

| Region | Count | Freq. | Occ | Rarely | Total |
|---|---|---|---|---|---|
| **A1** | **No** | | 1 | | 1 |
| | **%** | | 5,26 | | 5,26 |
| **A2** | **No** | | 1 | 2 | 3 |
| | **%** | | 5,26 | 10,53 | 15,79 |
| **B1** | **No** | 11 | 3 | 3 | 17 |
| | **%** | 57,89 | 15,79 | 15,79 | 89,47 |
| **B2** | **No** | 13 | 3 | 2 | 18 |
| | **%** | 68,42 | 15,79 | 10,53 | 94,74 |
| **C1** | **No** | 6 | 4 | 3 | 13 |
| | **%** | 31,58 | 21,05 | 15,79 | 68,42 |
| **C2** | **No** | 6 | 3 | 2 | 11 |
| | **%** | 31,58 | 15,79 | 10,53 | 57,89 |
| **D** | **No** | 6 | 5 | 2 | 13 |
| | **%** | 31,58 | 26,32 | 10,53 | 68,42 |
| **E** | **No** | 8 | 8 | | 16 |
| | **%** | 42,11 | 42,11 | | 84,22 |
| **F1** | **No** | | 1 | | 1 |
| | **%** | | 5,26 | | 5,26 |
| **F2** | **No** | | | | |
| | **%** | | | | |

The frequency of pain experienced by the experimental group was the highest in the following regions: right posterior cervical region (B2), left posterior cervical region (B1) and anterior and posterior head region (E).

Table 14: Summary of the severity of pain experienced in the regions of the body chart of the experimental group

| Region | Count | Severe | Moderate | Mild | Total |
|---|---|---|---|---|---|
| **A1** | **No** | | 1 | | 1 |
| | **%** | | 5,26 | | 5,26 |
| **A2** | **No** | | 1 | | 1 |
| | **%** | | 5,26 | | 5,26 |
| **B1** | **No** | 3 | 10 | 4 | 17 |
| | **%** | 15,79 | 52,63 | 21,05 | 89,47 |
| **B2** | **No** | 4 | 12 | 2 | 18 |
| | **%** | 21,05 | 63,16 | 10,53 | 94,74 |
| **C1** | **No** | 1 | 11 | 1 | 13 |
| | **%** | 5,26 | 57,89 | 5,26 | 68,42 |
| **C2** | **No** | 2 | 9 | | 11 |
| | **%** | 10,53 | 47,37 | | 57,9 |
| **D** | **No** | 2 | 8 | 3 | 13 |
| | **%** | 10,53 | 42,11 | 15,79 | 68,42 |
| **E** | **No** | 9 | 6 | 1 | 16 |
| | **%** | 47,37 | 31,58 | 5,26 | 84,22 |
| **F1** | **No** | | 1 | | 1 |
| | **%** | | 5,26 | | 5,26 |
| **F2** | **No** | | | | |
| | **%** | | | | |

The regions with the highest incidence of moderate or severe pain experienced by the experimental group were the anterior and posterior head region (E), right posterior cervical region (B2) and left posterior cervical region (B1).

Table 15: Comparison of the left-sided measurements of the static postural positions and total head and shoulder excursions for the extremes of frequency of pain in the experimental group (measured in degrees)

| Variable | Region | Never | Std Dev | Frequent | Std Dev | % Diff |
|---|---|---|---|---|---|---|
| Lnhp | B1 | 53,50 | 2,12 | 48,64 | 5,55 | 9,08 |
| Lnhp | E | 50,00 | 4,36 | 48,38 | 5,58 | 3,24 |
| Lmhp | B1 | 35,00 | 2,83 | 30,73 | 5,24 | 12,20 |
| Lmhp | E | 30,33 | 3,51 | 30,75 | 6,90 | -1,38 |
| Lmhr | B1 | 57,50 | 0,71 | 55,18 | 6,51 | 4,03 |
| Lmhr | E | 51,67 | 5,69 | 56,75 | 7,76 | -9,83 |
| Lthe | B1 | 22,50 | 2,12 | 24,45 | 8,41 | -3,68 |
| Lthe | E | 21,33 | 7,64 | 26,00 | 10,53 | -21,89 |
| Lcr | B1 | 161,50 | 4,95 | 163,64 | 6,45 | -1,33 |
| Lcr | E | 160,00 | 4,36 | 165 | 6,41 | -3,13 |
| Lnsp | C1 | 104,17 | 9,83 | 109,50 | 15,74 | -5,12 |
| Lnsp | D | 108,17 | 15,92 | 102,83 | 11,75 | 4,94 |
| Lmsp | C1 | 120,67 | 14,35 | 135,33 | 15,08 | -12,15 |
| Lmsp | D | 125,67 | 12,13 | 126,83 | 22,14 | -0,92 |
| Lmsr | C1 | 74,33 | 10,37 | 85,00 | 20,86 | -14,35 |
| Lmsr | D | 87,83 | 18,68 | 75,17 | 13,91 | 14,41 |
| Ltse | C1 | 46,33 | 11,57 | 50,33 | 20,55 | -8,63 |
| Ltse | D | 37,83 | 11,18 | 51,67 | 19,30 | -36,58 |

The highest level of frequency of pain in the left posterior cervical region (B1) revealed a greater range of left maximum head protraction. The highest level of frequency of pain in the anterior and posterior head region (E) demonstrated a greater range of left total head excursion. The highest level of frequency of pain in the left scapular and shoulder region (C1) revealed a greater range of left maximum shoulder protraction and a lesser range of left maximum shoulder retraction. The highest level of frequency of pain in the interscapular region (D) demonstrated a greater range of left maximum shoulder retraction and left total shoulder excursion. The standard deviations of the shoulder measurements were noticeably greater than those of the head measurements.

Table 16: Comparison of the right-sided measurements of the static postural positions and total head and shoulder excursions for the extremes of frequency of pain in the experimental group (measured in degrees)

| Variable | Region | Never | Std Dev | Frequent | Std Dev | % Diff |
|---|---|---|---|---|---|---|
| Rnhp | B2 | 45,00 | 0 | 51,62 | 5,55 | -14,71 |
| Rnhp | E | 52,67 | 8,02 | 49,62 | 5,29 | 5,79 |
| Rmhp | B2 | 38,00 | 0 | 32,46 | 4,99 | 14,78 |
| Rmhp | E | 36,33 | 1,53 | 31,25 | 6,48 | 13,78 |
| Rmhr | B2 | 50,00 | 0 | 58,15 | 8,15 | -16,30 |
| Rmhr | E | 55,67 | 9,81 | 56,62 | 9,46 | -1,71 |
| Rthe | B2 | 12,00 | 0 | 25,69 | 8,63 | -114,08 |
| Rthe | E | 19,33 | 10,21 | 25,38 | 9,61 | -31,30 |
| Rcr | B2 | 166,00 | 3,54 | 164,46 | 6,42 | 0,93 |
| Rcr | E | 162,67 | 3,51 | 165,38 | 7,78 | -1,67 |
| Rnsp | C2 | 100,00 | 15,66 | 99,50 | 15,40 | 0,50 |
| Rnsp | D | 98,00 | 16,36 | 105,00 | 13,89 | -7,14 |
| Rmsp | C2 | 122,75 | 9,63 | 126,00 | 22,69 | -2,65 |
| Rmsp | D | 120,17 | 13,09 | 134,33 | 11,47 | -11,78 |
| Rmsr | C2 | 74,00 | 16,35 | 78,17 | 15,69 | -5,64 |
| Rmsr | D | 78,00 | 16,84 | 78,17 | 19,09 | 0,22 |
| Rtse | C2 | 48,75 | 14,67 | 47,83 | 20,23 | 1,89 |
| Rtse | D | 42,17 | 21,29 | 56,17 | 17,46 | -33,20 |

The highest level of frequency of pain in the right posterior cervical region (B2) demonstrated a less protracted right neutral head posture and a greater range of right total head excursion and right maximum head protraction and retraction. The highest level of frequency of pain in the anterior and posterior head region (E) revealed a greater range of right maximum head protraction and right total head excursion. The highest levels of frequency of pain in the interscapular region (D) demonstrated a greater range of right maximum shoulder protraction and right total shoulder excursion. The standard deviations of the shoulder measurements were noticeably greater than those of the head measurements.

Table 17: Comparison of the left-sided measurements of the static postural positions and total head and shoulder excursions for the extremes of severity of pain in the experimental group (measured in degrees)

| Variable | Region | None | Std Dev | Severe | Std Dev | % Diff |
|---|---|---|---|---|---|---|
| Lnhp | B1 | 53,50 | 2,12 | 45,33 | 2,52 | 15,27 |
| Lnhp | E | 50,00 | 4,36 | 48,33 | 5,96 | 3,34 |
| Lmhp | B1 | 35,00 | 2,83 | 29,00 | 1,79 | 17,14 |
| Lmhp | E | 30,30 | 3,51 | 30,89 | 6,03 | -1,95 |
| Lmhr | B1 | 57,50 | 0,71 | 56,00 | 5,27 | 2,61 |
| Lmhr | E | 51,67 | 5,69 | 57,00 | 7,25 | -10,32 |
| Lthe | B1 | 22,50 | 2,12 | 27,00 | 3,61 | -20,00 |
| Lthe | E | 21,33 | 7,64 | 26,11 | 9,58 | -22,41 |
| Lcr | B1 | 161,50 | 4,95 | 168,33 | 5,77 | -4,23 |
| Lcr | E | 160,00 | 4,36 | 167,00 | 5,41 | -4,38 |
| Lnsp | C1 | 104,17 | 9,83 | 106,00 | 0 | -1,76 |
| Lnsp | D | 108,17 | 15,92 | 103,50 | 0,71 | 4,32 |
| Lmsp | C1 | 120,67 | 14,35 | 119,00 | 0 | 1,38 |
| Lmsp | D | 125,67 | 12,13 | 139,50 | 10,61 | -11,01 |
| Lmsr | C1 | 74,33 | 10,37 | 74,00 | 0 | 0,44 |
| Lmsr | D | 87,83 | 18,68 | 66,00 | 1,41 | 24,85 |
| Ltse | C1 | 46,33 | 11,57 | 45,00 | 0 | 2,87 |
| Ltse | D | 37,83 | 11,18 | 73,50 | 12,02 | -94,29 |

The highest level of severity of pain in the left posterior cervical region (B1) demonstrated a more forward resting head posture and a greater range of left maximum head protraction and left total head excursion. The highest level of severity of pain in the anterior and posterior head region (E) revealed a greater range of left maximum head retraction and left total head excursion. The highest level of severity of pain in the interscapular region (D) demonstrated a greater range of left total shoulder excursion and left maximum shoulder protraction and retraction.

Table 18: Comparison of the right-sided measurements of the static postural positions and total head and shoulder excursions for the extremes of severity of pain in the experimental group (measured in degrees)

| Variable | Region | None | Std Dev | Severe | Std Dev | % Diff |
|---|---|---|---|---|---|---|
| Rnhp | B2 | 45,00 | 0 | 47,25 | 6,18 | -5,00 |
| Rnhp | E | 52,67 | 8,02 | 51,67 | 5,39 | 1,90 |
| Rmhp | B2 | 38,00 | 0 | 33,00 | 4,69 | 13,16 |
| Rmhp | E | 36,33 | 1,53 | 32,11 | 5,62 | 11,62 |
| Rmhr | B2 | 50,00 | 0 | 54,00 | 9,31 | -8,00 |
| Rmhr | E | 55,67 | 9,81 | 57,33 | 8,86 | -2,98 |
| Rthe | B2 | 12,00 | 0 | 21,00 | 12,94 | -75,00 |
| Rthe | E | 19,33 | 10,21 | 25,22 | 8,93 | -30,47 |
| Rcr | B2 | 166,00 | 0 | 161,25 | 5,85 | 2,86 |
| Rcr | E | 162,67 | 3,51 | 167,89 | 6,13 | -3,21 |
| Rnsp | C2 | 100,00 | 15,66 | 108,50 | 16,26 | -8,50 |
| Rnsp | D | 98,00 | 16,36 | 99,50 | 3,54 | -1,53 |
| Rmsp | C2 | 122,75 | 9,63 | 135,00 | 7,07 | -9,98 |
| Rmsp | D | 120,17 | 13,09 | 131,00 | 1,41 | -9,01 |
| Rmsr | C2 | 74,00 | 16,36 | 83,00 | 32,53 | -12,16 |
| Rmsr | D | 78,00 | 16,84 | 62,50 | 3,54 | 19,87 |
| Rtse | C2 | 48,75 | 14,67 | 52,00 | 20,90 | -6,67 |
| Rtse | D | 42,17 | 21,29 | 68,50 | 2,12 | -62,44 |

The highest level of severity of pain in the right posterior cervical region (B2) and anterior and posterior head region (E) demonstrated greater ranges of right maximum head protraction and right total head excursion. The highest level of severity of pain in the right scapular and shoulder region (C2) revealed a lesser range of right maximum shoulder retraction. The highest level of interscapular pain (D) demonstrated a greater range of right maximum shoulder retraction and right total shoulder excursion.

# 5. DISCUSSION

## 5.1 Comparison of head and shoulder posture between the experimental and control group

Head and shoulder postural differences were observed between the experimental and control groups. The means for neutral head posture of both the experimental and control group fell within the values that have been reported in the literature for healthy people but the experimental group's neutral head posture was slightly more protracted than the control group. This indicated that the experimental group had a more forward resting head posture than the control group. This finding is consistent with those of other studies (Braun1991, Manneheimer and Rosenthal 1991, Watson and Trott 1993). The experimental group were able to protract their heads further than the control group. The experimental group showed less ability to retract their heads than the control group. The means for total head excursion of the experimental group were less than those of the control group. These findings are similar to those observed in Braun's (1991) study.

The means for cranial rotation of both the experimental and control group were similar in value to those measured in Harrison et al's (1996) study but differed in the fact that the means of the experimental group were greater than those of the control group. This is in contrast to a number of other studies. According to some authors the further the head is inclined anteriorly from the vertical plumb line, the more the upper cervical spine is likely to be extended (Ayub et al 1984, Braun and Amundson 1989, Darnell 1983, Kendall 1993). The experimental group had a slightly more forward resting head posture than the control group and therefore one would have anticipated the means for their cranial rotation to be less than those of the control group. This finding supports the results of Raine and Twomey's (1994) study. Similarly, they did not observe a correlation between extension of the upper cervical spine and a forward resting head posture. The means for cranial rotation of the control group were noticeably less than that of the healthy participants of Raine and Twomey's (1994) study.

The experimental group was less protracted in their neutral shoulder posture than the control group. This finding differs from those of other studies. According to the literature a more protracted neutral shoulder posture should co-exist with a more forward resting head posture (Ayub et al 1984, Braun and Amundson 1989, Darnell 1983, Kendall 1993). The means for maximum shoulder protraction of the experimental and control groups were similar. This finding differs from Braun's (1991) study where the mean of the symptomatic female group was noticeably greater than that of the asymptomatic female group. The means for maximum shoulder retraction the experimental group were greater than those of the control group. The experimental group's means for total shoulder excursion of were less than those of the control group. These findings are consistent with those of Braun's (1991) study.

The standard deviations of the means of the shoulder measurements of both the experimental and control group were noticeably greater than those of the head measurements i.e. the means were more widely spread. This might indicate that the method used to measure the shoulder measurements is less accurate than that of the head measurements.

It is of the opinion of the researcher that the maximum protraction and retraction measurements of the head and shoulders are of limited value. These measurements do not give an indication of either tissue and joint extensibility or muscle control. The measurements might vary between the participants for different reasons e.g. joint hypo / hypermobility, lengthening / shortening of muscle tissue, muscle spasm and poor muscle control.

None of the participants of this study had the "ideal" postural alignment as described by Kendall et al (1970). The results of this study suggest that postural abnormalities are associated with pain but the researcher agrees with Harrison et al's (1996) proposal that postural correction should be a trend in the direction of the norm for that patient's representative population i.e. age and gender rather than attainment of the "ideal". Further cross-sectional age- and gender- matched studies are required to determine postural norms. Additional studies are also recommended to evaluate the relationship between improved postural alignment and the incidence of symptoms.

## 5.2 The relationship between the frequency and severity of pain and head and shoulder posture in the experimental group

In the experimental group a relationship between the frequency and severity of pain in certain body regions and selected postural measurements was observed. This is in contrast to Griegel-Morris et al's (1992) study. They found no relationship between the severity of postural deviations and the frequency and severity of pain in the thoraco-cervical-shoulder region. However they observed that the subjects with more severe postural abnormalities had a significantly higher incidence of pain.

In general the experimental group had less range of movement (total excursion) of their head and shoulders than the control group but the highest level of severity and frequency of pain in certain regions resulted in greater excursions. The highest level of frequency and severity of pain in the anterior and posterior head region (E) demonstrated a greater range of left and right total head excursion. The highest level of frequency and severity of pain in the right posterior cervical region (B2) and the highest level of severity of pain in the left posterior cervical region (B1) demonstrated greater ranges of total head excursion. The highest level of frequency and severity of pain in the interscapular region (D) resulted in a greater range of left and right total shoulder excursion and left and right maximum shoulder retraction. The highest level of frequency and severity of pain in the left and right posterior cervical regions (B1 and B2) resulted in greater ranges of maximum head protraction. A number of these findings might be the result of poor cervical and scapular muscle control caused by chronic pain. Specific muscle testing would be necessary to prove this.

### 5.3 Analysis of the questionnaire

Results of the questionnaire showed that there was no significant difference in the body mass index ($kg/m^2$) between the experimental and control group. Similarly, Niemi et al (1996) found no relationship between neck and shoulder symptoms and body mass index. In contrast, Mäkelä et al (1991) observed an increased prevalence of chronic neck syndrome in association with being overweight.

The experimental group's ability to carry out activities of daily living was significantly affected by their chronic cervical pain. Thirteen of the nineteen in the experimental group (68,42 percent) were unable to carry out their activities of daily living for a period of time. In this study daily chores, leisure time activities and sports were included under the heading of "other activities of daily living". This significant finding supports the results of Diener's (2001) study. Thirty-four percent of her subjects reported an interference with their daily chores and thirty-two percent with their participation in sport and leisure time activities.

There was no significant difference in the number of hours worked per week by either group. There was a tendency for the control group to devote a greater number of hours to "active" leisure time activities. A number of studies have shown that dynamic exercise might have a preventative effect on the occurrence of occupational neck and shoulder symptoms (Dimberg 1989, Karppi et al 1994, Levoska and Keinänen-Kiukaaniemi 1993). The control group might have been less symptomatic as a result of devoting a greater number of hours to "active" leisure time activities than the experimental group. This finding highlights the necessity to further investigate the effect of exercise on postural correction and the prevention of cervical symptoms.

# 6 LIMITATIONS OF THE STUDY

The majority of the selected postural positions did not demonstrate a significant relationship with the frequency and severity of pain. It is possible that the sample size of this study might have influenced these findings. It is recommended that further investigations should be conducted on a larger sample size.

The occupations of the participants could not be analysed because of the sample size. In a larger sample size occupation might be relevant. Similarly gender, body mass index and hand dominance might also be relevant in a larger sample size.

Simple and relatively inexpensive equipment was utilised to perform this study. The reason for this was to demonstrate to fellow colleagues that valuable research could be carried out in a clinical environment without incurring major expenses. Processing postural measurements with the use of a computer-linked digitiser might be more accurate than the method used in this study. Further research should be carried out to compare the accuracy of measuring posture with a transparent grid, protractor and ruler versus computer-linked digitising.

The participants in this study were allowed to rehearse the maximum head and shoulder protraction and retraction positions prior to taking the photographs in an attempt to minimize error. The researcher observed that some of the participants appeared to move more freely as they became more familiar with the testing environment. The researcher therefore suspects that some of the participants might not have achieved their maximum range of movement of all the postural positions. It is suggested that in addition to rehearsing the positions, manual guidance should be provided to assist the participants into their maximum protracted and retracted head and shoulder postures. Dalton and Coutts' (1995) successfully followed this experimental procedure in their study.

In this study a chest strap was utilised to provide comparability with Braun and Amundson's (1989) and Braun's (1991) studies. The purpose of the strap was to promote a stable sitting posture for the participants. The researcher agrees with Grimmer (1993) that adequate mid-thoracic stability can be obtained by instructing the participant to maintain constant thoracic pressure against the backrest of the chair. The strap might unduly constrain the usual relaxation of the lower cervical and upper thoracic spine. It is also possible that the participants would be more relaxed with the procedure of measuring the five static postural positions if they were not constrained. This is in agreement with Refshauge et al's (1994) (ref 36) comment that is not usual physiotherapy practice to constrain patients.

Refshauge et al (1994) (ref 36) took a posterior photograph of each of their subjects to determine whether the markers on the spinous processes of the vertebrae had deviated from the sagittal plane. The use of a posterior photograph might increase the accuracy of this study.

Refshauge et al (1994) (ref37) demonstrated that the correlation between surface and vertebral body measurements of cervical inclination improved when the second cervical and second thoracic vertebrae were used. Further research should be carried out to compare the accuracy of using traditional surface markings such as the tragus of the ear and spinous process of the seventh cervical vertebra with the spinous processes of the second cervical and second thoracic vertebrae.

The scale used in the questionnaire to determine the annual affect of cervical pain on activities of daily living was obtained from the standardised Nordic neck questionnaire. The researcher believes that the category 8-30 days is too broad to provide an accurate conclusion. Studies to determine the reliability of the standardised Nordic neck questionnaire have shown a 30 percent disagreement using the same category (Kuorinka et al 1987). It is suggested that narrower intervals should be included in the scale.

# 7 CONCLUSION

The aims of this study were firstly to compare the sagittal head and shoulder posture and demographic variables of patients suffering from chronic cervical pain (experimental group) to those of "healthy" volunteers (control group). Secondly, to investigate the relationship between the frequency and severity of pain and the sagittal head and shoulder posture of patients suffering from chronic cervical pain (experimental group).

The main conclusions arising from this study are summarised as follows:

- Sagittal head and shoulder differences were observed between the experimental and control group.
- A relationship was observed between the frequency and severity of pain in certain body regions and selected postural measurements of the experimental group.
- The experimental group's ability to carry out activities of daily living was significantly affected by the frequency and severity of pain.
- The control group tended to devote a greater number of hours to "active" leisure time activities, which might have resulted in them, being less symptomatic.

When comparing the head and shoulder posture between the experimental and control groups, the following findings supported postural relationships that have been described in the literature. The experimental group had:

- a more forward head resting posture;
- greater head protraction;
- less head retraction;
- less shoulder retraction;
- less range of movement (total excursion) of their head and shoulders.

The following findings were in contrast to clinical assumptions that have been described in the literature:

- A forward resting head posture was not related to a protracted neutral shoulder posture or to upper cervical spine extension.
- The experimental group's cranial rotation was greater than that of the control group.

- The experimental group's neutral shoulder posture was less protracted than that of the control group.

A number of the relationships observed between the frequency and severity of pain in various body regions and selected postural measurements in the experimental group were probably the result of poor muscle control caused by chronic pain. This emphasises the need to assess the influence of tissue and joint extensibility and muscle control on head and shoulder posture.

**APPENDIX A**

**QUESTIONNAIRE**

Date of inquiry (year / month / day)

Gender 1. Female

2. Male

Age

Occupation ______________________________________________

1. How long have you been doing your present type of work? (years and months)

2. On average, how many hours a week do you work?

3. Describe the main tasks you perform in your job and estimate the percentage of your time spent on these tasks (e.g. Data capturing 60%, writing 20%, filing 20% = 100%)

______________________________________________

______________________________________________

______________________________________________

4. How much do you weigh? (kg)

5. How tall are you? (cm)

6. Are you right-handed or left-handed? 1. Right-handed

2. Left-handed

7. Do you have a history of scoliosis or any other skeletal problems? Yes

No

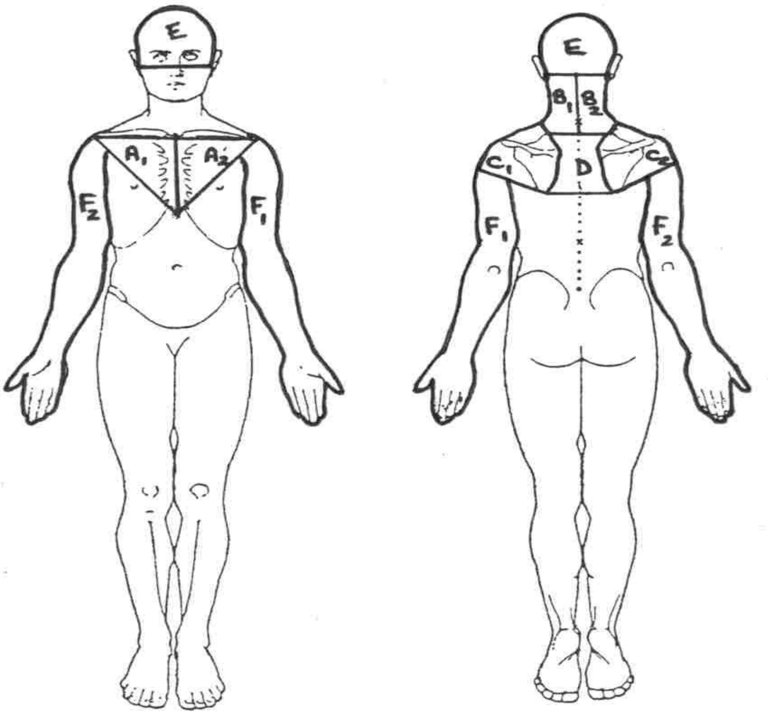
If so what are they?

______________________________________________

______________________________________________

8. Have you ever hurt your neck in an accident? Yes

No




9. Circle the numbers and letters below that best describe the pain that you may experience in the regions indicated in the diagram. (See description of scales below the table).

| Region | Frequency | Severity |
|---|---|---|
| A1 | N R O F | 0 1 2 3 4 5 6 7 8 9 10 |
| A2 | N R O F | 0 1 2 3 4 5 6 7 8 9 10 |
| B1 | N R O F | 0 1 2 3 4 5 6 7 8 9 10 |
| B2 | N R O F | 0 1 2 3 4 5 6 7 8 9 10 |
| C1 | N R O F | 0 1 2 3 4 5 6 7 8 9 10 |
| C2 | N R O F | 0 1 2 3 4 5 6 7 8 9 10 |
| D | N R O F | 0 1 2 3 4 5 6 7 8 9 10 |
| E | N R O F | 0 1 2 3 4 5 6 7 8 9 10 |
| F1 | N R O F | 0 1 2 3 4 5 6 7 8 9 10 |
| F2 | N R O F | 0 1 2 3 4 5 6 7 8 9 10 |

**Scales**

| | | |
|---|---|---|
| Frequency | N = never | |
| | R = rarely | (1 time per month or less) |
| | O = occasionally | (2 – 3 times per month) |
| | F = frequently | (1 or more times per week) |
| Severity | 0 = none | |
| | 1 – 3 = mild | |
| | 4 – 7 = moderate | |
| | 8 – 10 = severe | |

10. What is the total period of time that pain in any of the regions indicated on the diagram have prevented you from carrying out your job in the past 12 months?

0 days

1-7 days

8-30 days

more than 30 days

11. What is the total period of time that pain in any of the regions indicated on the diagram have prevented you from carrying out other activities (e.g. housework, leisure time activities) in the past 12 months?

0 days

1-7 days

8-30 days

more than 30 days

12. Have you been seen by a general practitioner, neurologist, physiotherapist, chiropractor or other such person because of pain in any of the regions indicated on the diagram in the past 12 months?

Yes

No

If so, which medical professional have you seen?

________________________________________

________________________________________

________________________________________

13. Name the 3 leisure time activities (e.g. running, aerobics, gardening, watching television, reading) you devote most of your time to.

1.________________
2.________________
3.________________

14. How frequently do you participate in these leisure time activities?

1. R O F
2. R O F
3. R O F

15. How many hours per month do you participate in these leisure time activities?

1.

2.

3.

**APPENDIX B**

# INFORMED CONSENT FORM

I have fully explained the procedure and rationale of my study. I have asked whether any questions have arisen regarding the procedure and answered any questions to the best of my ability.

DATE ___________________ RESEARCHER'S SIGNATURE ________________

I have been fully informed as to the procedure to be followed. In signing this consent form I agree to participate in the study. I understand that I am free to refuse to participate or withdraw my consent and discontinue my participation in this study at any time. I also understand that if I have any queries the researcher will answer these.

DATE ___________________ SUBJECT'S SIGNATURE _____________________

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